Universiteit Leiden

ICT in Business

Infrastructure management according to Enterprise Architecture

Name: Leon Meuldijk
Student-no: S1309706

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1st supervisor: Drs. Bas Kruiswijk
2nd supervisor: Dr. Hans Le Fever

MASTER'S THESIS

Leiden Institute of Advanced Computer Science (LIACS)
Leiden University
Niels Bohrweg 1
2333 CA Leiden
The Netherlands

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Acknowledgement

This thesis research document is the final report to obtain the Master of Science degree at Leiden University.

During the last 2 years I have been studying for the post experience study “ICT in Business” at Leiden Institute of Advanced Computer Science from Leiden University. This was a very turbulent time for my family and me due to various circumstances like job changes for both of us, two removals from the Randstad to Nijmegen Area and the restoring of our new house, an old T-farm build in 1885. We barely had time yet to integrate with the local peasantry which is quite required to get things arranged in this area.

I would like to thank my supervisors Bas Kruiswijk and Hans le Fever for their guidance and mentorship during this thesis research and the complete study, especially to support my tight planning to do this thesis research. I thank everybody who supported me during this Master of Science study.

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Last but not least, I want to congratulate my son with achieving his bachelor degree the same time I was doing this Master study.

Leon Meuldijk
August 29 2014

Abstract

This thesis research is executed to investigate to what extend Enterprise Architecture (EA) can be used for defining the management scope of the IT infrastructure team. (what do they have to manage and how are they equipped). A literature study is performed to inventory theories regarding Information Management, IT service delivery, architectural principles of Service Delivery, Knowledge Management, Enterprise Architecture and ArchiMate. The Enterprise Architecture of Canisius-Wilhelmina Ziekenhuis (CWZ) in Nijmegen is visualized with ArchiMate together with special attention of the impact on the IT department.
In a conceptual model the requirements for delivering a functional IT functionality (Hoving & Bon, 2012) are identified as People Product Process. Besides these three items Ability is identified as capability measure of the IT infrastructure team. A breakdown of Ability results in four types of points of interests: Empowerment and Motivation as catalysts and Knowledge and Competence as talents. A combination of these two models results in three main common factors between EA and IT infrastructure management:

- People
- Product
- Knowledge.

Indicators to define impact from the changing environment on the Infrastructure Management Scope are identified as follows:

- New functional requirements and updates
- Change in intensity of application use
- Change of quality requirements
- New platform releases
- Out of support of equipment
- New technologies and developments

CWZ is intending to replace their old Hospital Information System (ZIS) with a new Electronic Healthcare Record (EHR) system. This case is used for this thesis research. In the case study The Products are directly defined with the EA. The People item as the size of the team is depending on the amount of the IT systems and applications. Knowledge is defined as requirement and is added into EA. The types of required Knowledge can be specified in four groups:

- Knowledge about customer needs and requirements
- Knowledge about technical configurations
- In depth application knowledge
- Knowledge for maintaining platform

With this, all main requirements are fulfilled to determine the management requirements for the IT infrastructure team. The model is not a calculation tool to determine the size of the team and required knowledge, but is a model to identify the attention point assisting to define the management scope. With the case study is proven that the model provides enough information to determine the management scope of the IT infrastructure team. The CWZ internal master plan (Klein & Appel, 2013) to prepare the team and the infrastructure for the implementation of the new EHR provides a comparable approach. With this master plan is proven that the conceptual model is not only working, but also providing comparable information as conventional methods.

1. Introduction and Background

1.1 Research background

Enterprise Architecture (EA) is nowadays one of the most respected ways to align the various layers: business organization, business process, application landscape and technical ICT infrastructure. With EA, visibility can be created to give insight in the relation between the various architecture layers from different business and ICT viewpoints. In case of changes in business processes or the application landscape, the impact on the other areas can be visualized.

The capabilities of the infrastructure management team must match the technical infrastructure to be able to support the ICT environment in the most efficient way. In a dynamic environment, ICT management is constantly tuning the scope of the infrastructure team to be able to deliver an adequate service. When service requests for new services are received, the IT management has to define the impact on the infrastructure team and when the management scope of the infra team changes they have to justify possibly extra budget to the higher management.
A case study into this phenomenon will be performed within the CWZ hospital in Nijmegen, but the results should be applicable to any other organization with a medium to large ICT environment. CWZ is intending to replace their old Hospital Information System with a new Electronic Healthcare Record (EHR) system. This case will be used for this thesis research.

1.2 Problem description

In the current economic landscape, lots of companies have to fight their position on the market. To stay competitive, the way business is done is constantly improved. So where optimizing is possible, no company will withhold this. To stay in control of the internal processes, many organizations are using Enterprise Architecture to visualize mutual dependencies and the impact of changing internal processes. When companies are restructuring their business to stay competitive, this could change the application landscape. A change of this application landscape can however impact the management scope for the infrastructure team. When the impact of a business change is evaluated with EA, is it possible to include the potential impact on the infrastructure team in the same evaluation?

1.3 Research Question

Research Question:
To what extent can the management scope (required capabilities and capacity) of an IT infrastructure team be defined using Enterprise Architecture.

To create clarity about the content of the research question, a breakdown of the research question is convenient:
Definition of “Management Scope of an IT infrastructure team”.

An explanation of the product of an IT infrastructure team could be:
An IT-service is the delivery of functioning IT-functionality (Hoving & Bon, 2012)
The “IT infrastructure” is the IT environment required for the IT-service.
The IT infrastructure team is responsible for correct functioning of the IT-infrastructure.
The “Management Scope of an IT infrastructure team” is all the team has to manage and administer to deliver the required IT-service.

In technical sub-divisions dividable: systems management, network management, workplace management, application management, database management, helpdesk
The IT service is an integration of People, Process and Product (Hoving & Bon, 2012).
The people are the people them self, knowledge, skills and motivation.
The processes are an operational set of procedures, work instructions and orders (ITIL, Prince2, ISM and so on)
The product is the functioning IT-functionality

The scope of the infrastructure team can differ per company regarding Information Management and Functional (Application) Management. Later on we create more clarity about the preferred

Sub Questions:

1. To what extent can the required knowledge areas of the infrastructure team be defined with the use of Enterprise Architecture?
   - Service delivery is depending on e.g. capacity and ability. What is the relation of the delivery scope and the capability of the team and is it possible to visualize with EA
2. To what extent can ArchiMate be used to visualize the scope of management, internal processes and required knowledge for the infrastructure team?
   - Is ArchiMate appropriate to support this research?
3. To what extent can new requirements for the ICT infrastructure team be visualized using Enterprise Architecture? Can the impact on outsourced services be visualized?
   - Is it possible to use EA to define required changes on the infrastructure team and the way of sourcing?

1.4 Methodology

A pre-investigation is done into the possibilities of ArchiMate to verify the feasibility for this research. A literature study is performed to get background knowledge of the subjects to be investigated. In the case at CWZ the modeling of EA is performed to demonstrate the possibility of visualizing the management scope, processes and required knowledge of the ICT infrastructure team. In a case study a change of applications (the migration of the ZIS to an EHR system) will be performed to investigate the impact on the infrastructure team. Just to prevent getting bogged down by too much detail, only parts of the landscape will be modeled to a level still usable for this case.

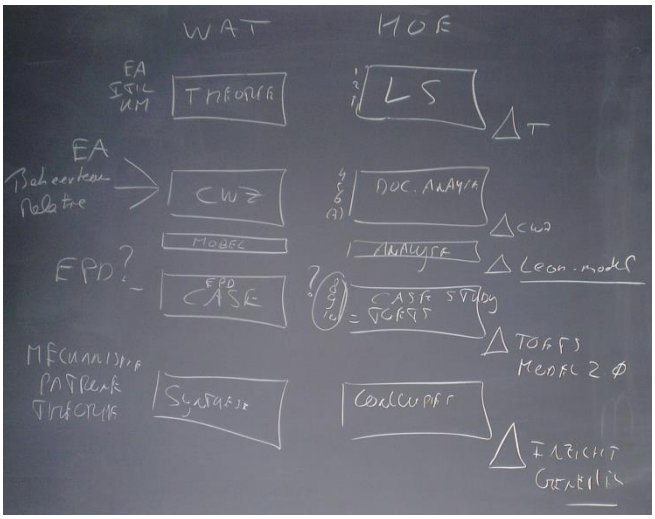


Fig. 1 Blackboard session about approach with Bas

The following research steps are defined to perform this thesis research:

1. Literature study:
- Enneahedron model written by Rik Maes.
- Beheren onder architectuur written by Bart de Best
- ISM methode written by Wim Hoving and Jan van Bon
- Management van Kennis written by Prof.dr. Jacques Boersma
- Use of ArchiMate
- If applicable additional literature

Purpose of the literature study is to determine the measure of influence of architectural changes on the IT service.

2. The CWZ environment will be used as a case to visualize the application landscape and the infrastructure with the use of EA. With this visualization the relation of EA to the infrastructure management scope can be assessed. EA of CWZ will be made, as also the architecture of the IT Infrastructure organization.

3. Is it possible to create a framework or model to support this relation?
What are possibilities to create a model to support the relationship between EA and the infrastructure management scope.

4. Case study to define the Delta infrastructure scope by implementing a new Electronic Healthcare Record (EHR)system. With a case study, the suggested theory and model can be proven to be valid as tool to redefine the infrastructure management scope in case of EA changes

5. Gap analyses as-is and to-be situation. With this gap analyses additional actions can be defined.

1.5 Relevance

Academic Relevance

- ICT systems management is an activity. Activities are not part of architecture, so Infrastructure-Management-Architecture does not exist. But, is it possible to use EA to define the scope of activities and abilities of the ICT infrastructure team.
- This thesis research will provide a framework of dependencies for the scope of infrastructure management

Practical relevance

- This thesis research will give clarity about the scope of infrastructure management in relation to the business architecture and the application landscape.
- Clarity about whether changes in EA can cause changes in the scope of the infrastructure management visualized by the use of ArchiMate

2. Literature Review

2.1 Information management according to Rik Maes

Rik Maes et al have written several papers about the scope and the position of information management as part of the PrimaVera working paper series. They have used the strategic alignment model (Henderson & Venkatraman, 1993) as basis of the enneahedron model for positioning of information management.

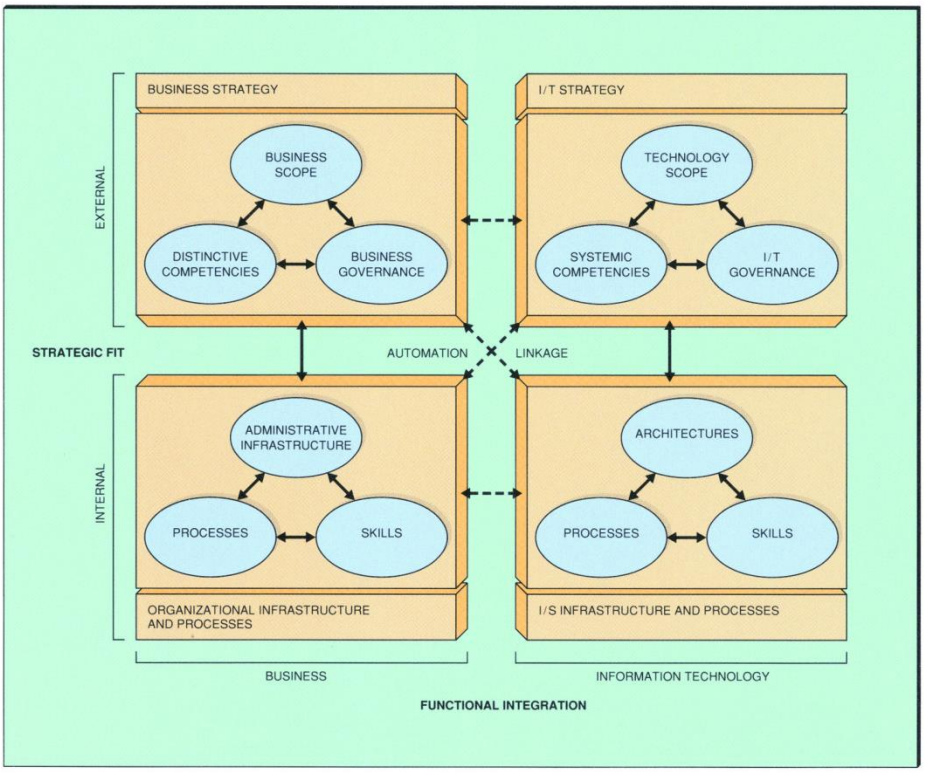


Fig2. The business-IT relationship according to Henderson & Venkatraman

Henderson and Venkatraman (1993) defined four type of business-IT alignment. Two of them are driven by the business strategy. The business strategy can be used to define the operational organization, the operational organization defines the IT requirements.(Strategy execution alignment perspective) The other business strategy driven way is to define the IT strategy as derivative of the business strategy. The IT strategy is used to define the IT portfolio. (Technology transformation alignment respective) The two other ways of business-IT alignment are IT driven. The IT strategy can be used to define the business strategy by supplying new IT developments to do business. The business strategy is used for defining the operational organization. (Competitive potential alignment perspective) In the last option, the IT strategy is used to define the IT operations which is used to define the business operations. (Service level alignment perspective)

The Henderson and Venkatraman model is use as a basis to define the enneahedron model for positioning of information management. (Maes, 2003) Between the strategy (external) and the operations (internal) a structure layer is defined. Between the business and IT an

information and communication layer is defined. This is a field of action which came into development at the beginning of the end of the nineties, start of 21st century.
The role of Information management came with this model in existence in a defined structure. Alignment of business requirements translated in the need for information and structure became the field of action for the Information Manager. (Abcouwer, Maes, & Truijens, 1997)

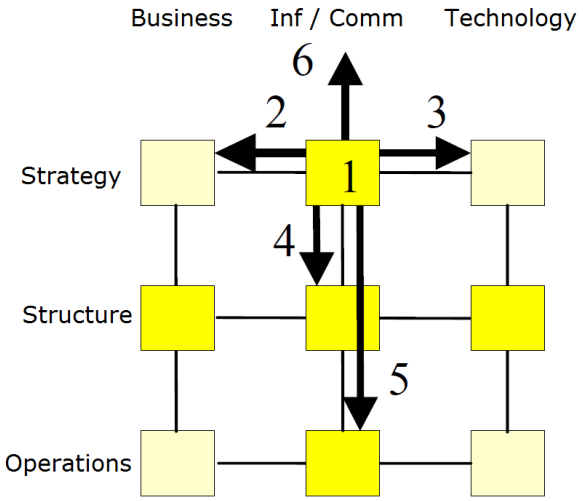


Fig. 3 Enneahedron model for positioning of information management with point of attention for the CIO

Lots of companies resort to appoint a specialist to handle this new field of attention. On corporate level it is called a Chief Information Officer (CIO), on business unit an Information Manager. The role of the CIO has several fields of attention. (Maes, 2004)

1. The information strategist formulates the information strategy depending on the business needs. The strategy is mainly business driven.
2. Business strategy advisor is co-defining and constructing the business strategy for information intensive organizations.
3. The ICT-portfolio manager is responsible for defining the long-term policy for the ICT portfolio, looking at future business needs and market developments
4. The organization architect is defining the EA with special attention for the information and communication capabilities of the organization.
5. The business advisor is advising the various levels of management with re-organizing business processes and the use of information to support the business.
6. The last task is the role as trend watcher to advise about new developments to support the business.

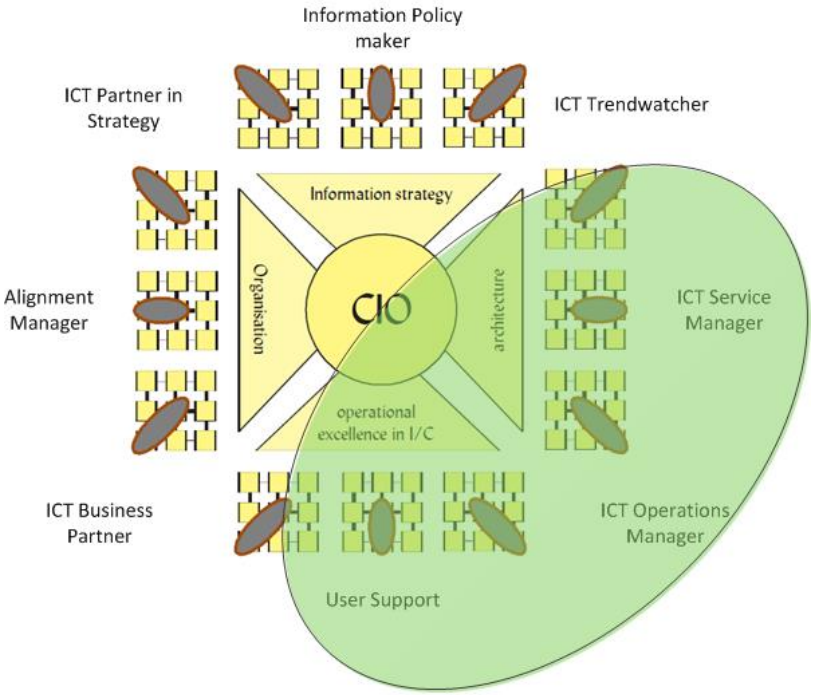


Fig. 4 Various ICT roles within the Enneahedron model

The scope of work of an ICT Infrastructure team it not only a matter of “keep the servers running”. With a more structured definition of information management, the role of IT infrastructure management expanded. During the last years functional requirements were not only provided by applications, so new functionality like cloud functionality, “Bring Your Own Device”(BYOD), Social Media and “The New Working” are very infrastructure related functionalities. Of course it is the role of the information manager to advice the business in using this functionality, however the boundaries with infrastructure management are becoming more vague. The scope of this thesis research is not only focusing on the pure IT related fields of the Enneahedron model but is covering the green area of figure 4.

2.2 IT Service Management Processes

The delivery of IT services is for a big part depending on the maturity of the IT organization. Maturity of an organization is measurable by levels of Maturity (Carnegie Mellon University, 2014). The Maturity is mainly depending on the internal processes of an organization or an sub-organization like an IT department.

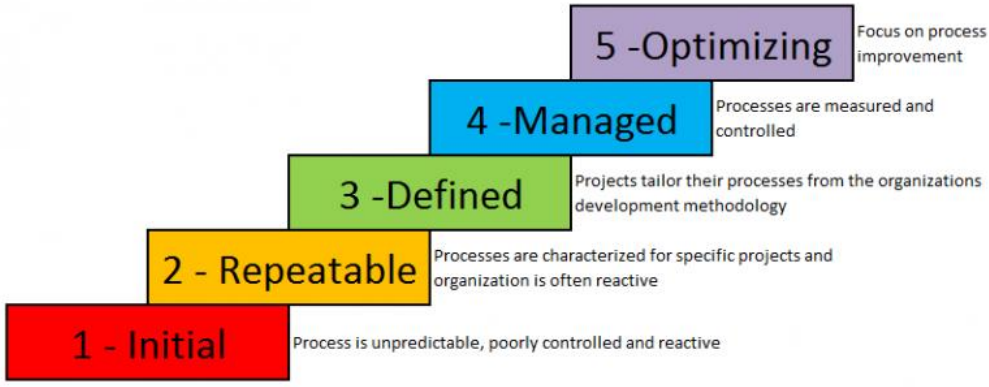
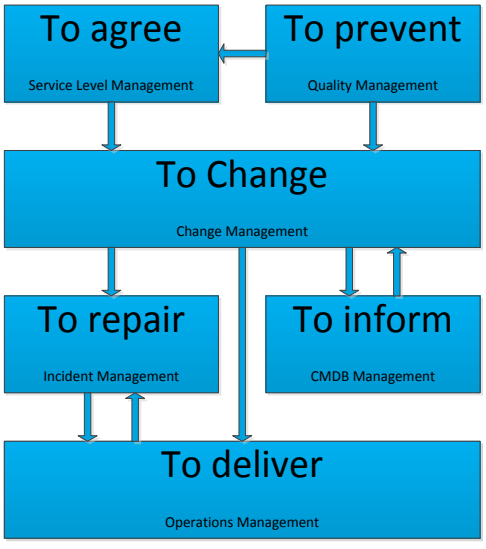


Fig. 5 CMMI Maturity Levels

Within IT organizations processes are mostly based on ITIL (Information Technology Infrastructure Library) best practices. (Axelos, 2014) ITIL version 3 is based on 29 processes which is with version 3 not only limited to the original focus of IT operations. Because of the wide scope of ITIL version 3, lots of organizations are limiting their self to a subset of the 29 processes.

Hoving and van Bon (2012) develop a multipurpose framework with 6 activities to manage operations. The IT version is called Integrated Service Management (ISM) (Hoving & Bon, 2012)



The framework is universal and applicable to multiple branches like IT Service Management (ITSM), Functional Management (FSM), but also Facility Management and other service delivery organizations.

The 6 processes are covering all possible activities of a service management organization.

When implementing ITIL or related, one of the first tasks is to inventory and define all steps of the processes.

Over 90% of the cases all processes are defined similar with the same components. This is why ISM is provided with predefined process descriptions.

Fig. 6 ISM Framework

To mark out the scope of ISM, Hoving and van Bon placed ISM in the Information Management Enneahedron, however they add a third dimension to the enneahedron to manage not only the processes, but to explain that service delivery is a combination of People, Process and Products.

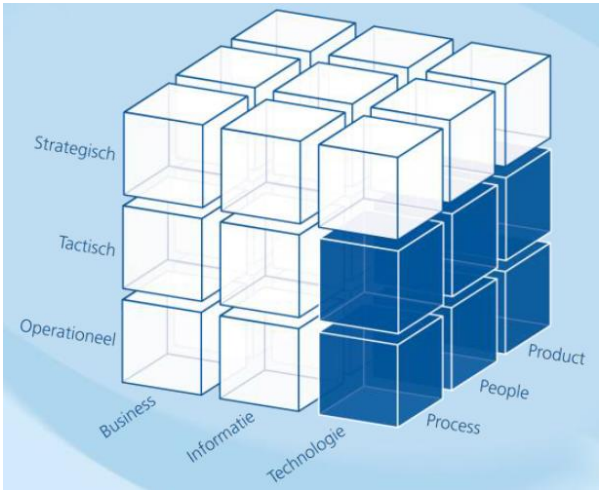


Fig. 7 The scope of ISM

The scope of ISM is defined on the roles mentions in the processes. It is not defined on functions or positions. In case an functional designer is solving an program error, he is using the ISM incident process. When a system engineer is solving a arithmetical error with Excel for a finance colleague, he is doing functional support and not ISM incident solving. ISM is focusing on the delivery of functioning IT-functionality. This is essential in the definition of the ISM scope. ISM is covering the blue blocks in the three dimensional Rubik's cube
The delivery of a functioning IT functionality is the sum of all components. (Best, 2006)
Processes are not limited to a certain specialism or a department. When the user is experiencing troubles with a functionality, it is covered by ISM.

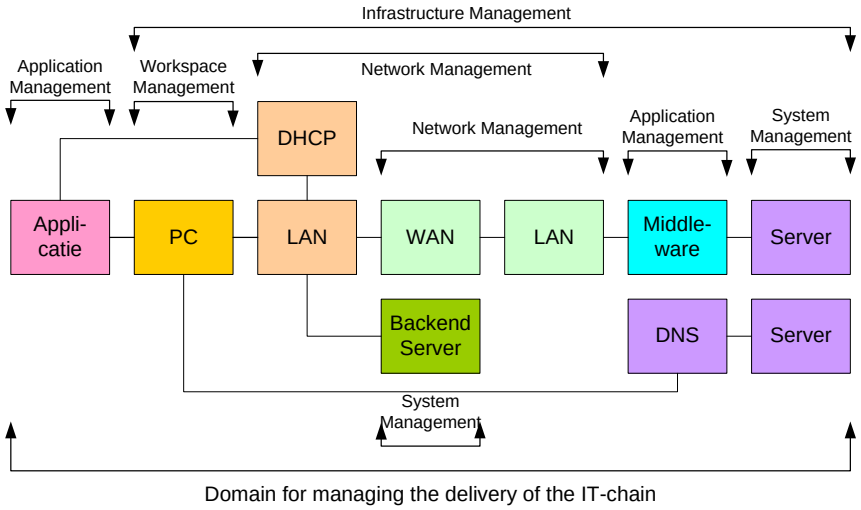


Fig. 8 IT-Chain Management

This is essential for the use of ISM to prevent excuses bypassing the processes.
The structure of the processes are quite similar qua structure. They are built as follows:

1. Intake
2. Categorize and Match
3. Analyze
4. Prepare
5. Execute
6. Finish

Only the change process is a bit more complex because there is more variance due to simple and complex changes and various approval steps.

There are 6 ISM processes according the verbs in figure 6 :

The focus is to deliver a functioning functionality.
When we experience a problem we are using the **Incident Process**. This can mean two possible solutions: The system can be reset (e.g. reboot) to restore the service or we use the **Change Process** (e.g. replace system) to solve the problem. The Change process is also used to install new services. When we have changed or installed a system we have to maintain the system, the **Operations Process**. In this process we have 2 variances: 1: service requests like password resets (everything is working correct, because in case you forgot your password, you not allowed to access the system) or 2: tasks to guaranty proper functioning like backup & restore, monitoring, checking error logs, intrusion detection etc. To request a new service, the **Service Level Process** can be used to negotiate the service levels for the service and the time and costs for installation and maintenance. This are the four left processes the customer can access directly. **The Quality Management Process** evaluates possible risks on the delivery of the service provisioning and takes action when required. Lots of risks are reported from statistics of the operations process. To know what we do and have done and which assets we are managing we use the **CMDB Management Process**, to register and more important to inform ourselves.

2.3 Architecture of Service Delivery

Service delivery is an activity and you cannot create architecture for activities. This is the subject Bart the Best struggled with in his book "Beheren onder Architectuur" (2008). He created a framework to visualize activities to define an architecture to give direction to define activities and acceptance criteria for IT service organizations.

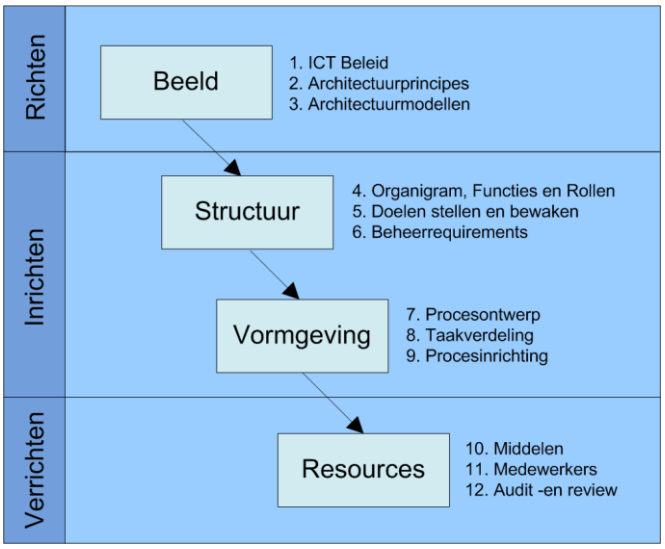


Fig. 9 BEheren onder Architectuur (BEA) framework

Bart defined the BEA framework to create structure and so Architecture for an IT Service Delivery organizations. It is based on the right column of the Enneahedron model of

information management. Align (richten) is defining IT strategy, governance, architectural principles and –models. Organize (inrichten) is a combination of Structure (structure) and Design (vormgeving). Structure is the defining of the functions and roles and assigning people to it. Setting targets and monitor them and the definition of the requirements for the IT infrastructure management are quality parameters defining the required IT service . Structure is comparable to the Service Level Management Process of ISM framework. Design is the process design, allocation of tasks and process descriptions, comparable with the predefined process description of the ISM model. Execute (verrichten) is the execution of processes as described in the ISM model with the process, people and products. In the BEA framework, every action is defined with Key Progress Indicators (KPI's) so it is easy to audit.

The BEA framework is based on a defining IT infrastructure management requirements, Risks and counteractions, acceptance criteria and audit processes. Monitoring is one of the active tasks to verify the delivered services, not only by component, but the complete operation chain as displayed in figure 8 (Best, 2006). Within the ISM framework we are talking about the delivery of a functional functionality, this is the same kind of service delivers as the chain of de Best.

Discussing the delivery if IT service all models have a common set of requirement to be able to deliver the required service. Hoving and van Bon (2012) defined them as Process, People and Product. People is however to be interpretable as capacity, bud also capacity and capability. Capability is a combination of skills, knowledge, and physical capability. Knowledge however is only part stored in people. (Boersma, 2002)

Knowledge can be stored in:

- human knowledge (humanware)
- documented knowledge (paperware)
- mechanized knowledge (hardware)
- automated Knowledge (software)

Knowledge is crucial for the ability of delivering service. Automated knowledge is knowledge defined in systems. E.g. the system which supports the ISM processes is guiding the IT employee though the process. He need to know how it works, but in-detail knowledge is covered by the system. Mechanized knowledge is e.g. a system which is automatically indicating a problem is experienced, like a copier which is showing where the paper got stuck and how to solve it. The difference between automated and mechanized knowledge is becoming vague because all hardware is internally using software nowadays.
So now only two types of knowledge are critical for the service delivery: documented knowledge and human knowledge.
Documented knowledge is the information how to maintain a system. This is available on the Internet, at the supplier or in course books. This is common information. Crucial information is how to maintain your system. This is depending on how your system is installed including all special settings and policies. This information needs to be documented and should be part of the work instructions.
Human knowledge is the most difficult knowledge to manage. It has a big overlap with the documented knowledge, but a IT technician need knowledge what to do instead of every time looking into the system to check. It is not only how to do things, but also what to do.

When a technician makes a backup, he need to know he has to test a restore once a while to make sure it is usable to recover the environment.

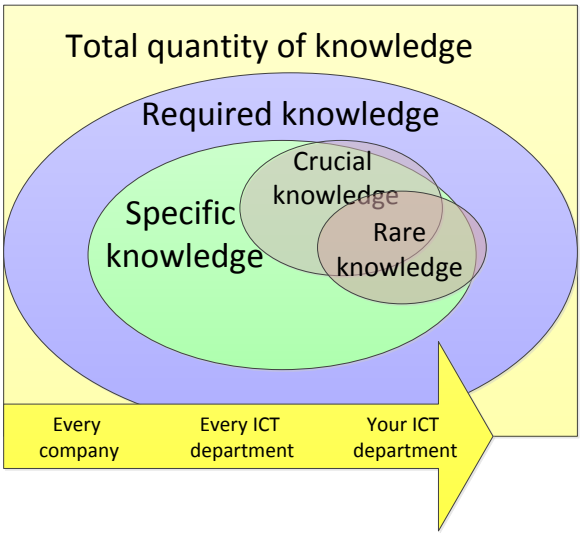


Fig. 10 Types of knowledge and their position

Knowledge management is essential to be able to deliver a functioning functionality. Otherwise the technicians need to search for every incident what the problem is. Professional knowledge and –skills are speeding up the incident solving very much. When technicians lacks professional knowledge, they cannot define proper designs, which is crucial to a reliable IT environment.
So the ability to manage an IT environment is not only depending on People, Process and Product, but is also depending on skills and knowledge. Knowledge is dividable into the components as shown in figure 10 and it is stored is a technical knowledge database and partly in the mind of the employees. For an IT operations team the information can be split in the four segments below.

General Information	General information about installing and maintaining IT environments	Latent information for performing a job like systems manager
Case Specific Information	Company specific information about that particular installation	Crucial information how to manage this specific environment
	Stored in technical knowledge database	Stored in employee minds

Table 1 Relation type of information and location stored

There is a big difference between skills and knowledge. Skills are the ability to apply knowledge. Competences are natural abilities strengthened with experiences and knowledge to do things. (Gagné, 2012)

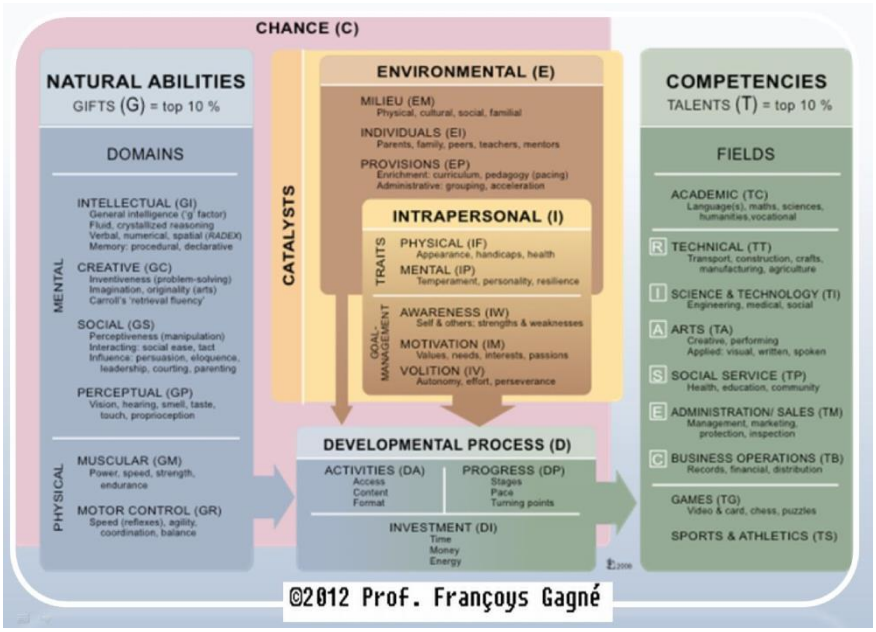


Fig. 11 Differentiated Model of Giftedness and Talent (DMGT)

Gagné developed a model to explain how ability to do things is established. There are natural gifts like intelligence and creativity. These gifts can be strengthened by catalysts like training, milieu, motivation and experiences. With this combination of catalysts the development of an individual can result in the required competences for a job. The natural gifts you can hardly affect. The catalysts are a combination of the environment and intrapersonal influence, which is better to affect.

A successful team is a combination of setting the right environment and having the appropriate people for the job. This is essential for successful delivering a functioning functionality.

2.4 Enterprise Architecture

Due to the New (Internet driven) Economy, organizations need to respond quickly on the fast changing customer requirements and business opportunities. Due to integration of business processes multiple responsible managers and stakeholders need to be informed about the impact of changes. Due to the levels of the various stakeholders an insight need to be created from multiple viewpoints. Next to that, insight need to be given about the dependencies on the various layers of the environment.

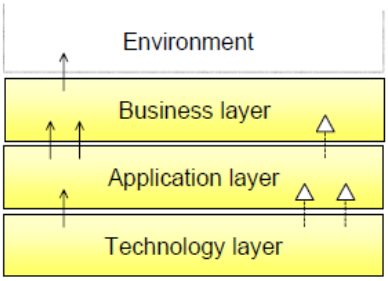


Fig 12. Main Architectural layers

To establish this insight and to be able to manage the whole of the environment Enterprise Architecture (EA) is used. There are multiple systems to administer and maintain EA like The Open Group Architecture Framework (TOGAF), Nederlandse Overheid ReferentieArchitectuur (NORA) and ArchiMate. ArchiMate is a modeling language to visualize EA and the relations between the components within the various layers from different viewpoint.

There are 3 main layers within ArchiMate. These layers cover their specific architecture and can be divided in sub layers, like the business layer can cover the sub-layers:

- External roles and actors
- External business services
- Business processes and internal actors and roles

ArchiMate is supporting multiple views to the Enterprise Architecture. In the past every responsible group documented there specific configuration in multiple systems. When we had an experienced team, the also made a graphical overview of the configuration with the dependencies within their expertise. Only network technicians made overviews covering multiple layers with dependencies, but still network related. This was initiated by the need to have overview of the dependencies of the 7 OSI layers. (IEEE, 1980)
With EA all actors, processes, software, hardware and logical components can be documented in one tool and with views it can show the landscape to all stakeholders in their own perspective with dependencies important to them.

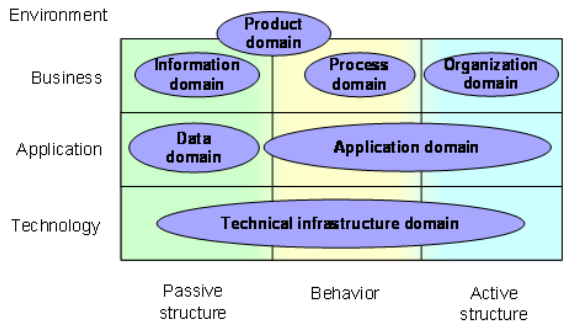


Fig. 13 Architectural framework with their layered views

Each layer contains information about objects and information, the behavior (services and processes) and active structure. With the active structure producers of that domain is described: For the business it means the actors and roles, for the application layer: the applications and related components and for the technology layer the devices and network structure.

	Object / Information	Behavior	Active Structure
Business	Business objects	Business servisec and processes	Actors and roles
Application	Data objects	Application services and functions	Applications and components
Technology	Artifacts	Infrastructure services and system software	Devices and networks

Fig. 14 layers and aspects within ArchiMate

With the increasing use of virtualization, the technology layer can be subdivided with a physical and a virtual layer. Every layer has the same structure. The same types of concepts and relations are used however the detailed content of information, processes and actors are different.

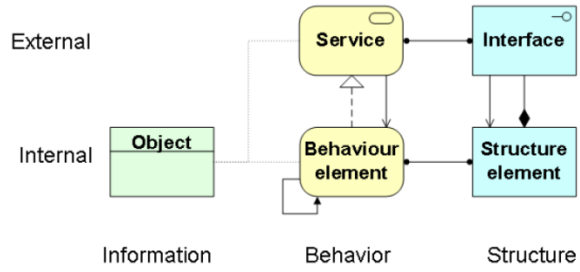


Fig. 15 Generic layer structure

The active structure is initiating the behavior on the information object. This generic structure is applicable to each layer and sub-layer. The business layer is providing services to the environment (see figure 12), as the application layer is providing services to the business layer and the technology layer provides services to the application layer.

The business layer as shown in figure 16 is showing the main components and their relations are defined within the business architecture. The objects and information are still in green, the behavior in yellow and the active structure (actors and roles) in blue.

Within the application layer the service to the business is defined as an application service (yellow) and an application (user) interface (blue). In the application layer metamodel only the basic components are defined. In practice, the layers can be defined with much more detail.

In the technology layer the infrastructure service (yellow) and –interface (blue) are the services to the application layer. The details can, depending on the architectural needs, be very detailed. It can defined as a aggregated service model, but also in node and connection detail.

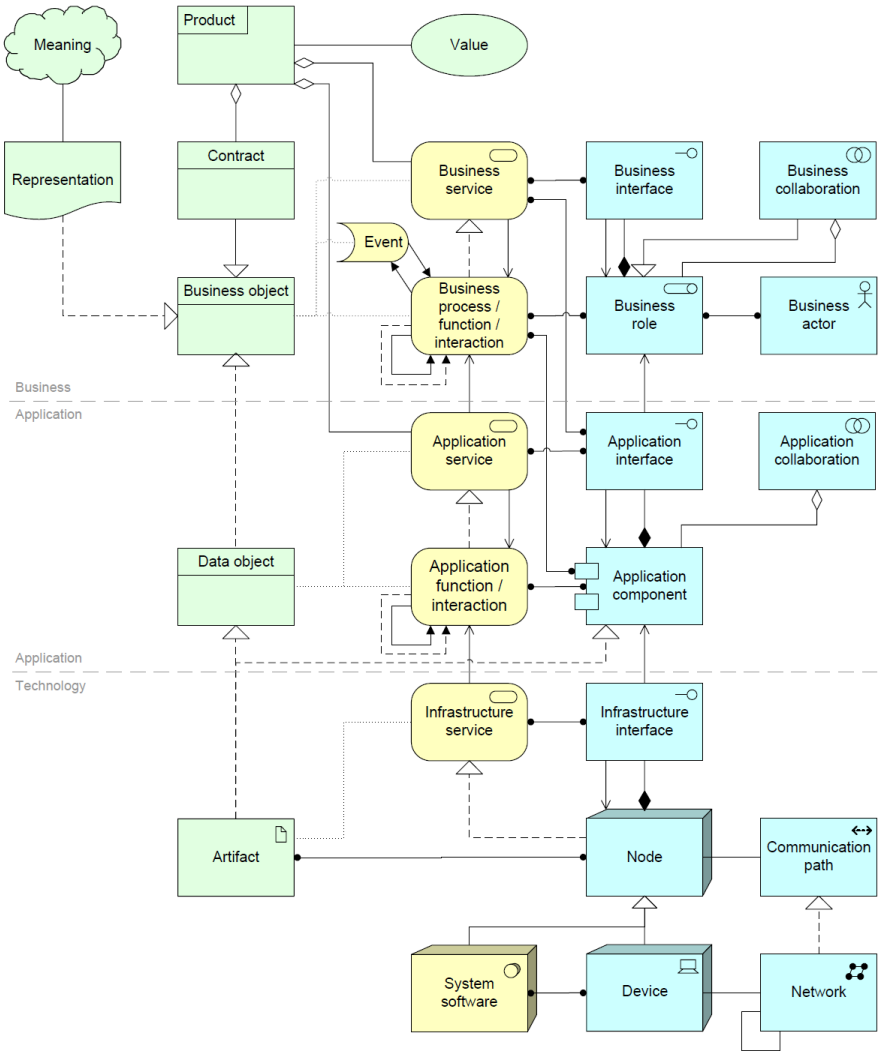


Fig. 16 ArchiMate metamodel

The EA metamodel as a summary of the aggregated business, application and technology layers. In the metamodel it is reduces to building blocks, but in practice is can be very detailed and display all business roles to all infrastructural components.

EA should be in that detail as it is required by their users. How more detail, the bigger the risk to get lost in the details. With the use of viewpoint, the views can be filtered so details are only visible to the user with the need for it. The power of ArchiMate is the ability to visualize the inter-domain integration of the various domains.

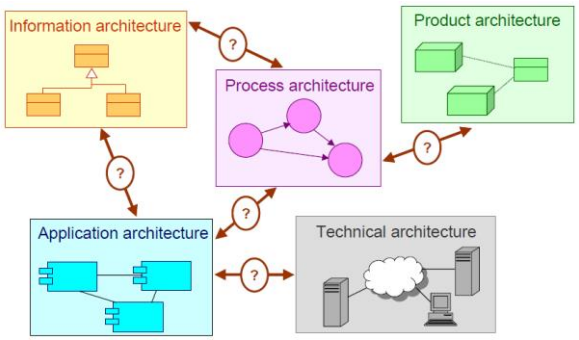


Fig. 17 Integration within and between the domains.

Depending the requirements of EA the level of detail can differ within the various layers. In case the focus is to optimize business processes, the technical architecture is not primary focus. The focus is at that moment the business process and the interfacing to e.g. the application layer and the external environment. However when multiple groups with different viewpoint are using EA, the detail can differ per audience.

3. CWZ Architecture

This thesis research is performed at CWZ hospital in Nijmegen. CWZ is one of the 27 top-clinical education hospital with 28 medical specialism, 8 paramedical departments and 5 special departments like ER and IC. CWZ is a medium size hospital with 550 beds and about 4000 employees. To perform this research a certain complexity in organization and ICT-environment is required. Next to that the organization need to be in a migration stage to be able to assess an as-is and a to-be situation and gap analysis. CWZ in the start of a hospital wide migration to a new Electronic Health Record (EHR) system meets both of the requirements. So CWZ is a valid environment to execute this research.

3.1 Business Architecture

The governance of the CWZ is designed by a Supervisory Board and a Board of directors for the daily operations. The Board of Directors is advised by the Client Council and the Works Council at one site and the Medical Staff at the other site. The Medical Staff is composed from Medical Managers from the Care Units and the Capacity Units.

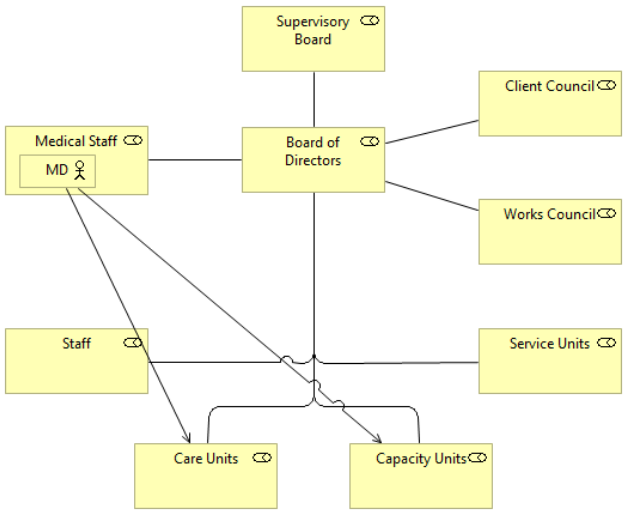


Fig. 18 CWZ Governance

The organization is mainly composed by Care Units, Capacity Units and Service Units. The Care Units are the Units responsible for the primary process, the treatment of the patients. The Capacity Units are providing hospital services to the Care Units like Pharmacy, Laboratories, Radiology and ER. The Service Units are providing business facilities like HR, Finance, IT and so on.

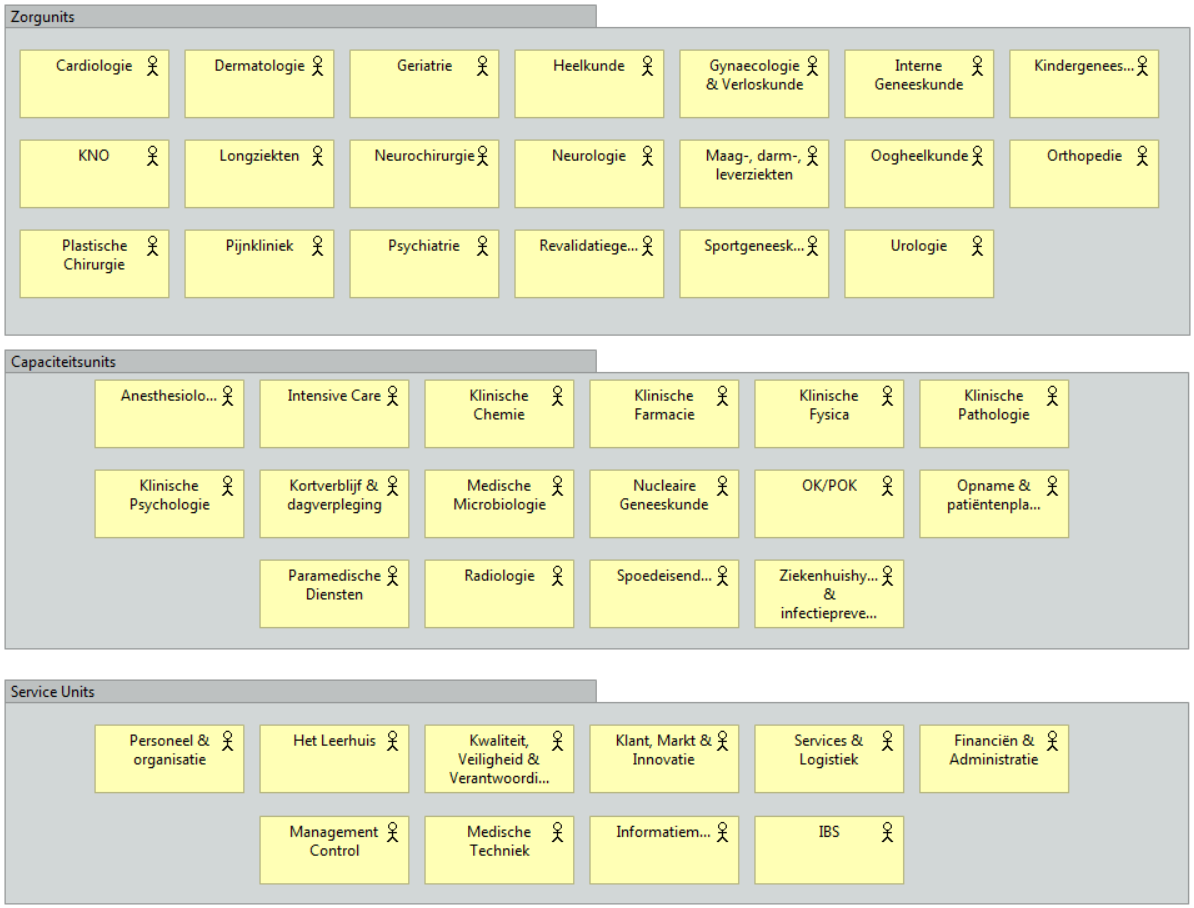


Fig. 19 Overview departments by type

The primary process of a hospital is quite simple and universal for all hospitals. (Polman, 2010) Except that every specialism is having its own version of process depending on the workflow the patient is treated by.

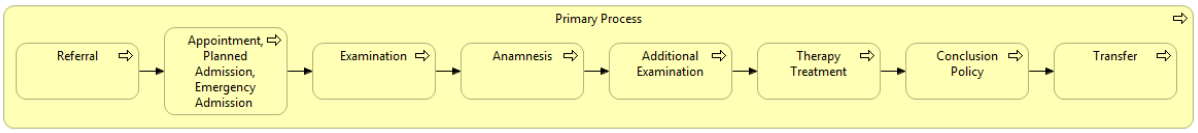


Fig. 20 Primary Care Process

However in general all patients are experiencing the same basic steps for treatments of their complaint. Also the process of Additional Examination is quite the same for each department.

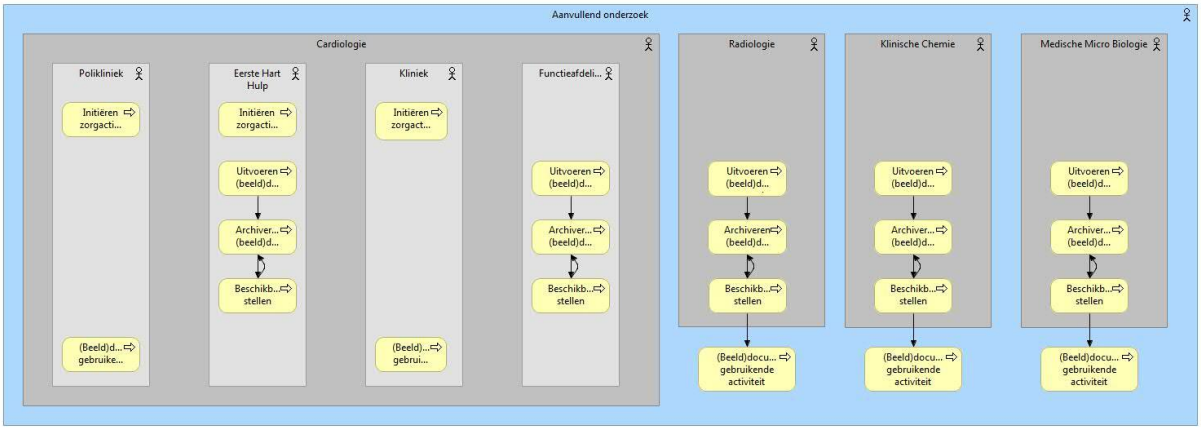


Fig. 21 Process for additional Examination

The processes for the Service Units are unit specific. So is HR responsible for their processes and underpinning application landscape. The finance department is responsible for their processes and so is the IT department for their processes and application landscape.
Be aware that this is currently the situation at CWZ, this is not applicable for all hospitals or other companies. This is not affecting this research, because it are the higher levels of the EA in relation to the infrastructure scope which is investigated, and they can differ for each company.
The fact that processes for the purpose of the care process are all quite similar, not means they all use the same applications. For processes where all departments are storing and using information, like patient registration and digital dossier, all departments have to use the same software and instance. But a laboratory is using different tooling then a radiology department and also different from an ophthalmologist. This makes the application landscape very complex because all data still need to be related to the correct patient and be stored in the right dossier. So there are very much data exchange relations between the total set of applications. For the AS-IS Application Landscape see appendix 1
Plotting all relations of all units(departments) into the application landscape is obfuscating the overview due to too much detail. The relation from primary process and Additional Examination to the Application Landscape to the IT infrastructure (the total EA) is important to get a complete overview. In this case it gives only too much detail (see logic information model in appendix 3) , so restriction to a subset of the landscape can give enough insight for the thesis research.

3.2 IT architecture

In this chapter a reduced overview of the IT architecture is discussed. We start with the Virtual Workspace. The Virtual workspace is a uniform desktop provisioning which can be used on multiple types of devices like PC, Thin Client or tablet and so on. On this Virtual Workspace applications can be provided like local apps as MS-Office or Acrobat suite, but also the client package of a centralize application like EHR, BI or ERP. The other IT architecture workouts are more application related which can be provided via the Virtual Workplace.

Virtual Workplace

The virtual workplace is a virtual PC running on a set of servers which can be accessed at a random device from a random fabric and operating system. This gives the medical care provider the flexibility to work from any place and type of device. When a Medical Doctor (MD) is doing outpatients, he can use the PC and on visit he can use his own “PC” on his tablet.

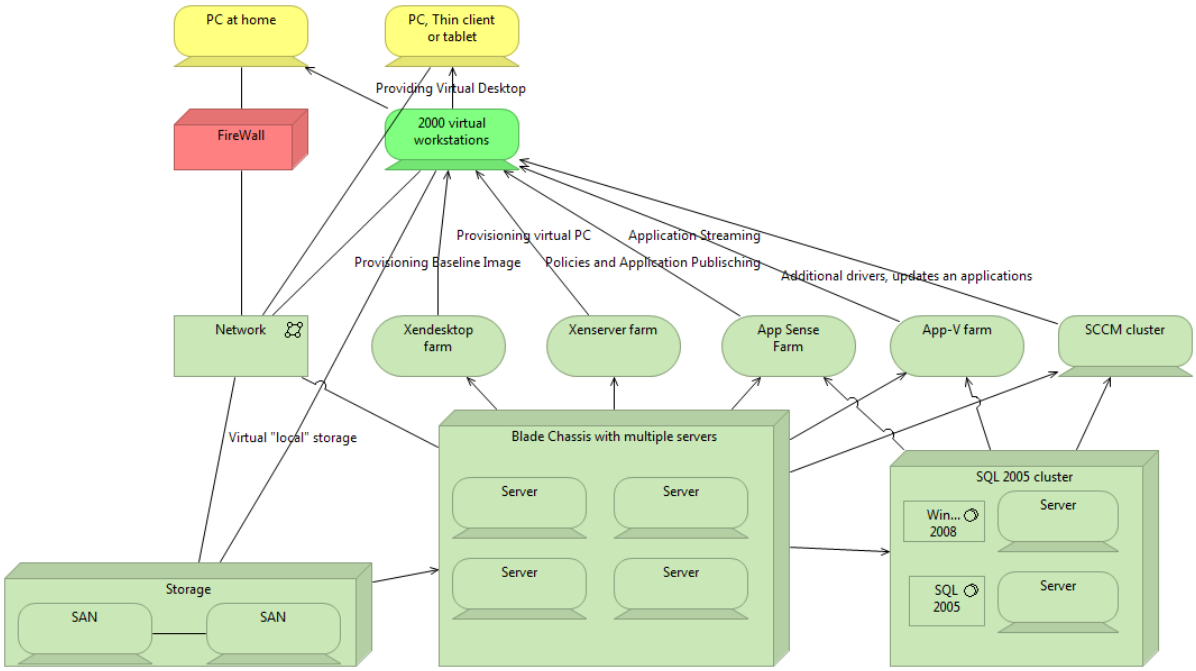


Fig.22 Virtual Workspace Infrastructure

Even when a doctor is on call or a second opinion during the night is required, he can access his own CWZ-PC on his home location or anywhere else. Always one pharmacist is on call in case special drugs need to be approved. He is equipped with a tablet with 4G connection so he is able to approve or deny anywhere, even during the groceries (live example).

EVS&DTR

For Pharmacists the application Zamicom or EVS(Electronisch Voorschrijf Systeem) is used to write out prescription. This is done at the ER, during outpatient treatment and other in-house treatments. This prescription is automatically added to the digital dossier. The application for providing the medicines is done during hospitalized stay by the nursing staff. This is done with the application Klinicom or DTR(Digitale Toediening Registratie). With this application all track and trace information of medicines is registered and related to the patient.

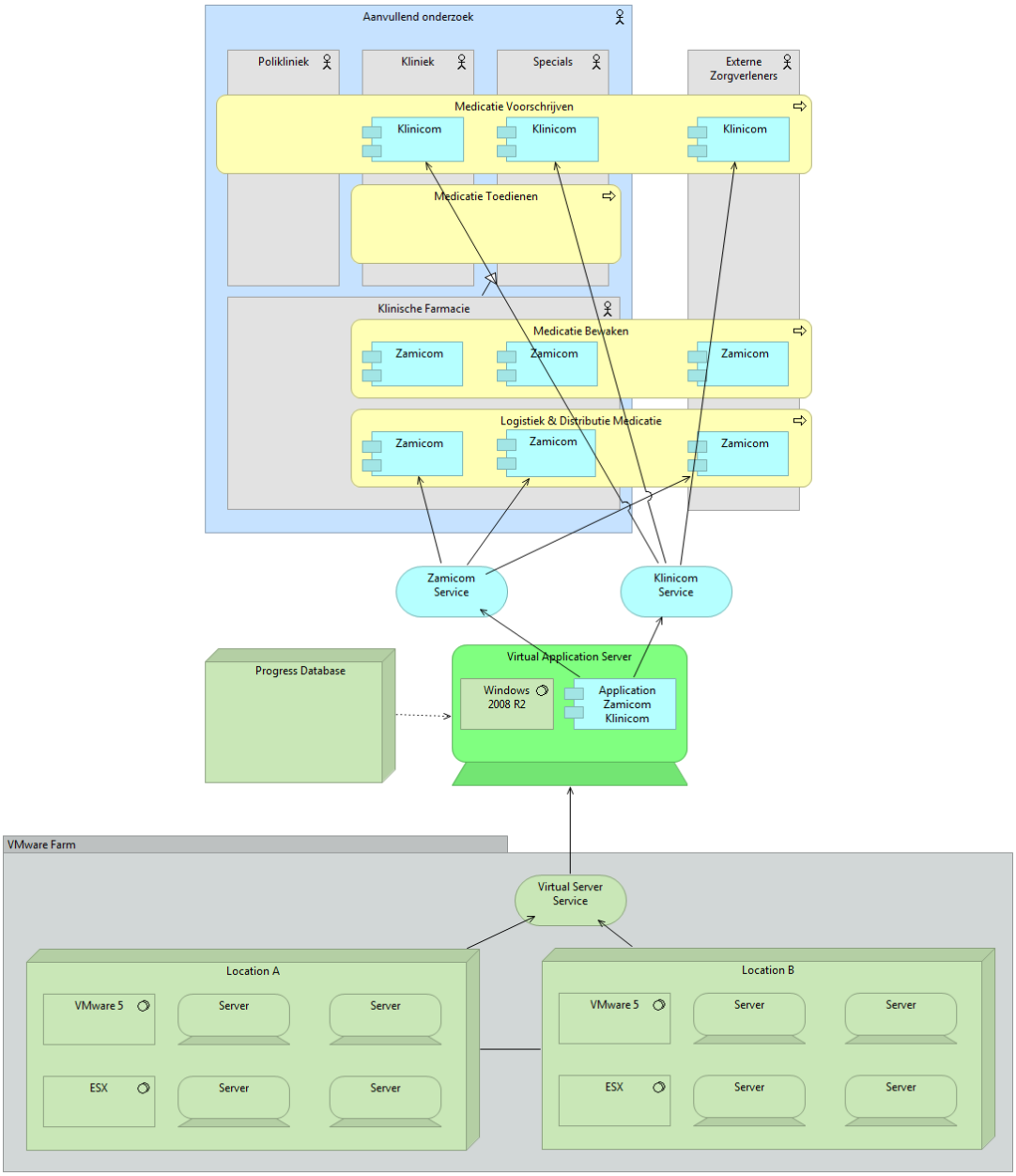


Fig.23 Zanicom and Klinicom environment

Within CWZ most if the servers are virtual provided by a VMware platform. This creates an extra sub-layer in the infrastructure layer.

Digital Dossier

The Digital dossier is part of the Mirador Package. With the various Mirador modules all kinds of information can be stores in the Hospital Information System (ZIS) environment. All information together creates the dossier. Mirador is a portal where a patient can be selected from the ZIS and the required functionality can be selected. In case you have selected a patient and you are reviewing the Digital Dossier, you can also check the prescription with Zamicom or check a radiology picture with a DICOM(Digital Imaging and Communications in Medicine) viewer. The communication between all applications are at two levels. All backend systems need to exchange patient record information with

HL7(Health Level 7) messages (Henket, Duin, Burghouts, & Kemenade, 2012). At the front-end applications are accessing each other with selected patient record number and identification of the care provider. This makes the communications very complex and requires extra measures to prevent patent interchange and database differences between the multiple systems

To access the Mirador Package, you have to access the virtual workspace facility. There is a real dependency on the virtual workspace. The non-ZIS modules are client applications from applications running on other servers, so there is also a dependency on the virtual server platform, especially in cases where Mirador has a start dependency on the availability of one of the modules. An example is the CDR service. Without accessibility of CDR, Mirador cannot start.

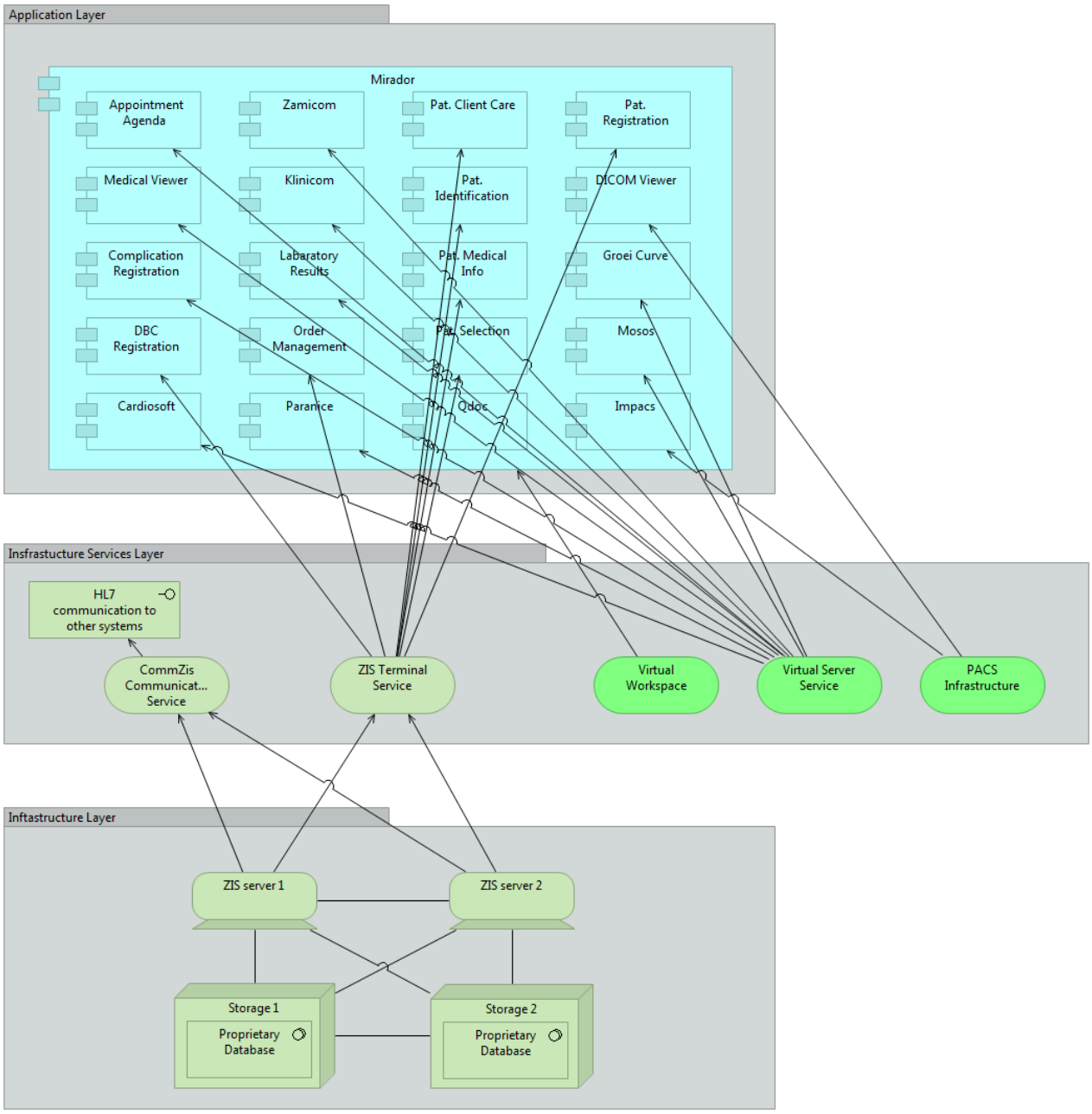


Fig. 24 Mirador Composition and Infrastructure

The ZIS backend is composed of a redundant set of storage with a ZIS database and a replica. The ZIS servers are able to access both databases, however for security reasons (and probably old technology) the switch-over is a manual action.

Picture Archiving and Communication System (PACS)

PACS is a system used by the radiologists and the cardiologists. You can say PACS is the system to store Rontgen photo's, however currently all kind of pictures like CT and MRI pictures are stored in PACS. The modalities (peripherals like the CT and MRI scanners) are producing all kind of picture formats, depending on the type of modality. To create uniformity all pictures are migrated to DICOM format and both DICOM and the original are stored, so data-loss is prevented.
With 3D now only selected screens are dicomized. Only future versions of DICOM do support 3D pictures. A PACS database is very big, one modern CT scan consists of 1000 High definition pictures, so one scan can be over 1Gb each. An average hospital makes over 3000 of these scans a week and need to be stored for minimal 25 years. PACS is also able to store the medical report with the pictures. At the reporting the MD is speaking the diagnose which is automatically converted into a text-document with the speech module.
The PACS model structure is displayed in appendix 8
The Cross Document Sharing(XDS) module provides a facility to share High Resolution Pictures with other parties in a safe way. This kind of information (medical information) is very confidential classified, so normal e-mail is not suitable for distributing this information, apart that some pictures are too big to mail.

The PACS infrastructure is built as a fully redundant set of systems to guaranty fault tolerance, degradability and availability. The data is stored on a redundant set of SAN's and the database is running on a redundant set of Sun Solaris machines. The applications are running of multiple virtual servers on a VMware farm to guaranty full availability.

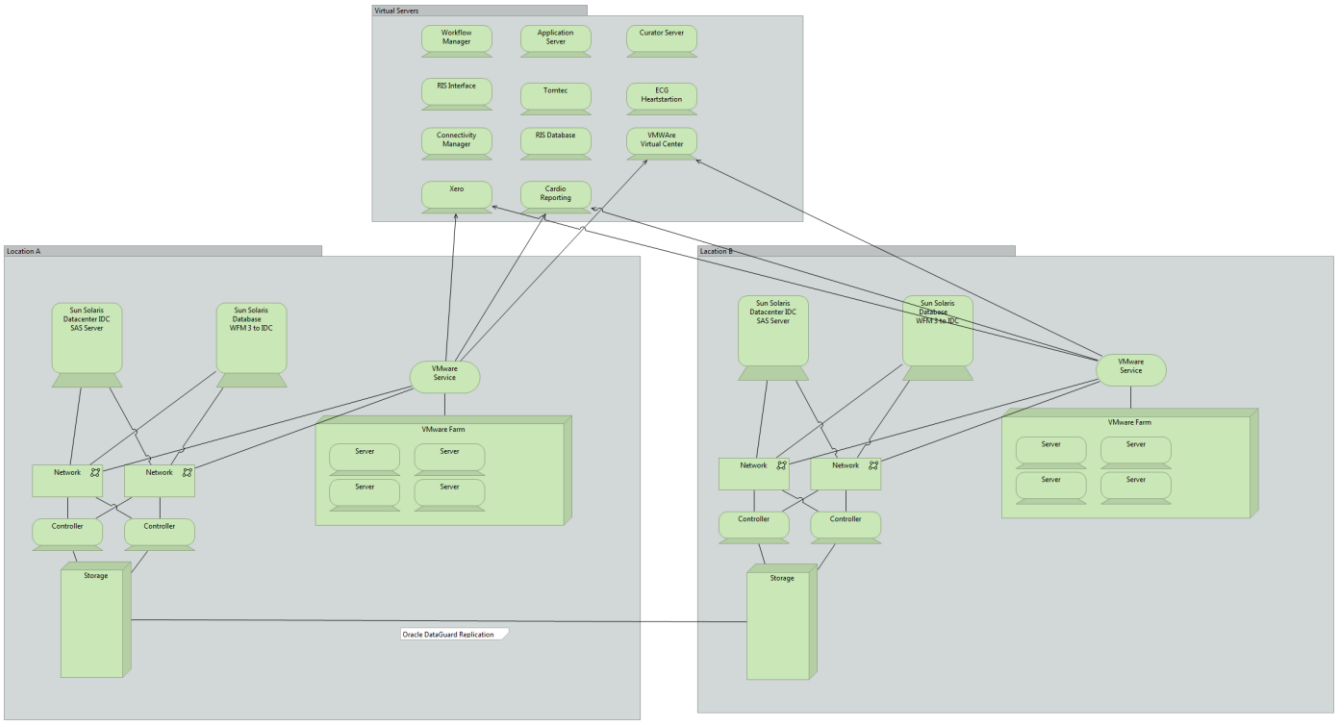


Fig. 25 PACS Infrastructure

4. Conceptual Model

In this conceptual model the theory of the literature study is used to define a model to determine the requirements for infrastructure management when changes in EA occur. The model consists of a focus point for service delivery and one for required knowledge. It is not a mathematical tool to calculate the required resources. There are too much influences to make that calculation, but is gives insight in attention points. In a case study this conceptual model is used to determine the impact of a major application change on the infrastructure management scope.

4.1 The Process – People – Product triangle

To create or deliver a product, three major components are required. Hoving and van Bon (2012) called it Process – People – Product in the Rubic's Cube version of the Maes Enneahedron. (Abcouwer, Maes, & Truijens, 1997) (figure 7)

- The process is the process of the IT organization to deliver the service. (appendix 5)
- The people are the Users able to use the IT service and the IT people to maintain the IT service
- The product is the application the user is using, but also all activities to create "the delivery of a functioning IT functionality"

In the middle of these three areas there is the ability to deliver this service which is based on the capabilities of the infrastructure team. We have to make a breakdown of ability to get to manageable components of this central factor in the capability of the Infrastructure team.

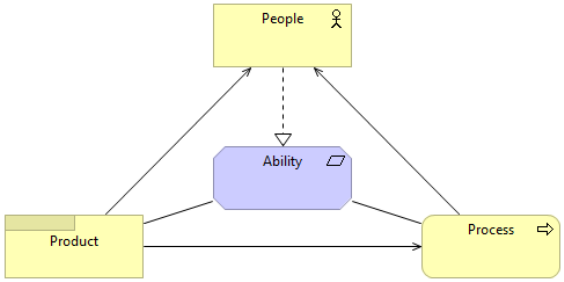


Fig. 26 Process – People – Product triangle with Ability to use it

Ability is the capacity of people using processes to create a product with available resources. However, without the ability to use the processes and the resources, the capacity of people is not able to create any proper result.

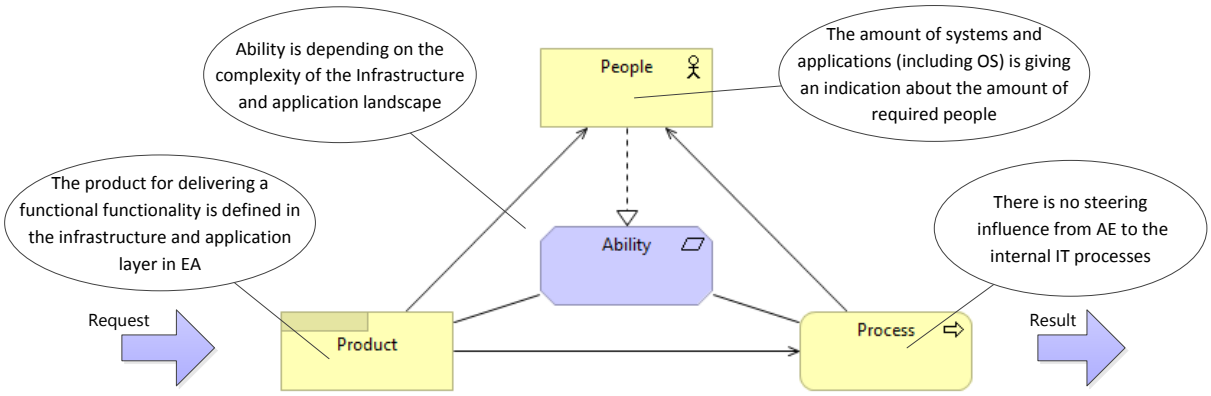


Fig. 27 Relation EA to Service Delivery Requirements

In figure 27 we can see that from the four components of Service Delivery People and Product have a direct relation to EA. The product is defined in EA and the amount of products and the variety of products gives an indication for the required amount of people maintaining the products. The Ability is depending on the products (what do we maintain) and the people (what are we able to maintain). Changes in EA do not affect the internal IT processes. They are defined and used to deliver the functioning IT functionality, but do not change when the product or service is changing. Work packs describing how to build or maintain an infrastructure component is custom made to that particular component and can change when the product changes, but the process is not changing. (Hoving & Bon, 2012)

4.2 Ability explored

Ability is a capability to make use of the Process – People – Product components in an effective and efficient way. Ability is the skills and knowledge of the IT people. Next to that, willing and mandate are required to make someone to do something. You can say it is a quality aspect (or technically a parameter) of the people factor. In that case it should not be the fourth component of the Process – People – Product triangle. However Ability is not only a quality aspect of people. It is also the availability of information how the infrastructure is designed and must be maintained. It is information about products, used and produced. It is the way people follow processes and the availability materials and tooling. It is information embedded in the processes. It is much more then skills, competences and knowledge of the IT staff. It is also the managerial space a team or developer receives to create a product using his own creativity.

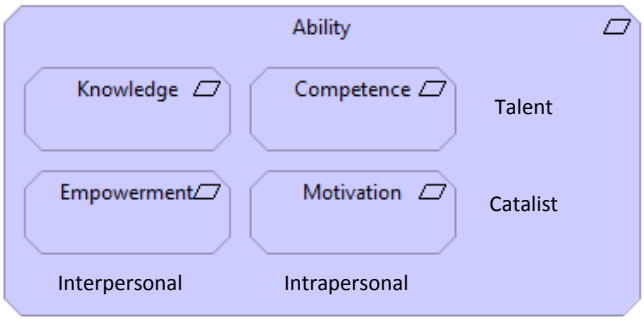


Fig. 28 Factors for Ability

Figure 28 gives an overview of the four major influences of Ability.
Talent is the skill to do something and is a combination of competence and knowledge. Competence like technical insight is hard to influence, but the knowledge is to train. Knowledge is adjustable to the requirements from the products and is relatable to components of EA. Competence is a natural gift people have or lack at birth. It is hard to train people is natural gifts.
Motivation is a catalyst to things better and is a personal feeling. People feeling well are more able to do things, but feeling well is only partly to influence. Empowerment is the space a manager or organization can offer to succeed. Empowerment is giving people the space and mandate to do things. Without empowerment people are restricted in productivity
All of the four factors are responsible for an efficient and effective person or department.

Knowledge is the collection of interpretable information available to the company, business and IT staff. Most of the information is documented in systems and a part is latent available in the minds of the people. (Boersma, 2002) The information in the minds of the people is crucial for the operation of the department. This information makes the people capable of doing their job.
Some skills and competences are inherent (Intrapersonal) and some of the skills and competences you can easily influence. (Gagné, 2012) Some skills like technical insight are hard to influence, but for other matters like knowledge you can train people.

Empowerment and Motivation are Human Resource Management (HRM) related. This are influences outside the scope of EA. Competence and Knowledge are related to the products and so related to EA. However, Competence is hard to influence and is an selection criteria in the employment process. Nevertheless, the required level of competence is related to the complexity of the infrastructure and application landscape. Knowledge is directly relatable to the design of the infrastructure and used components in EA.

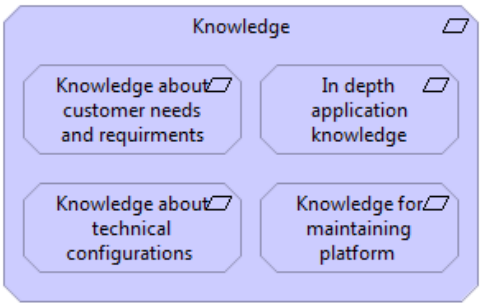


Fig. 29 Required types of knowledge

As we can see in figure 29, we identified 4 types of required knowledge in a generic piece EA.

- Knowledge about customer needs and requirements
- Knowledge about technical configurations
- In depth application knowledge
- Knowledge for maintaining platform

Assumed this are the most important knowledge components extractable from EA perspective.
We concluded that with EA we made requirements for the people and products regarding the service delivery of IT services. Another relation was made between EA and the Ability of the Infrastructure Team to effectively manage the environment. In this chapter we analyzed the Ability and concluded that available knowledge and the competence of people are related to the in EA described environment, Empowerment and Motivation are not. The competence of people is a part of the people requirement. During the recruitment process of people the competence is one of the selection criteria.
So the only manageable relations between EA and the delivery of IT services are now identified:

- The People creating, maintaining and delivering the IT services.
- The Products used to deliver the IT service, namely the Infrastructure and the application landscape
- The Knowledge to be able to deliver the IT service and maintain the IT infrastructure.

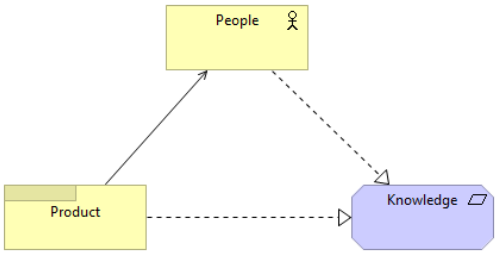


Fig. 30 PPK model to relate EA to IT Infrastructure Management

4.3 Trigger to architecture changes

The business requires the delivery of a functioning IT functionality for executing the business processes. These business processes are supported by an application landscape. The application landscape is giving direction to the underpinning infrastructure design or in case the infrastructure organization is very mature, the infrastructure architecture can give direction to the application landscape. In both cases there is a strong relation between the infrastructure and the application landscape.
The infrastructure team is responsible for delivering a functional IT functionality. This IT functionality is liable to changes. These changes can be triggered by the business and the maintaining infrastructure team. The business requires functionality according defined quality requirements. Both the functionality as the quality requirements can change. Technical developments can require changes to guarantee support and reliability according the agreed service levels.
Quality criteria are secondary business requirements and give direction to both application and system architecture (Paauwe & Paauwe Wijnands, 2010). There is a wide range of quality criteria according to ISO/IEC 25010:2011 (British Standard Institution (BSI), 2011) formerly known as NEN9126. For example the requirement for availability can result in mirrored systems on different locations. The requirement for fault tolerance and recoverability can result in double systems with synchronized databases. So the quality requirements are very important to the technical design of the infrastructure and the software design.

Triggers to change requests of the environment from business and infrastructure view are identified as follows:
Changes initiated by business:

1. **New functional requirements and updates**
   New functional requirements are covered with application changes, updates or new additional applications. Besides this, these requirements can result in additional infrastructure and required in depth application knowledge and additional user questions at the support (help) desk. In EA this trigger is identifiable by changes in the application landscape.

2. **Change in intensity of application use**
   In case an application is more used then before, there is no impact on the application landscape. This stays the same. However, is can be necessary to extend the server

and database to be able to host the increased use of the application. This trigger is identifiable by an increase of licenses or extra infrastructure to host the application, so this can have impact on the amount of support requests and infrastructure management.

3. **Change of quality requirements.**
   Quality requirements of an application or infrastructure can be a requirement for reliability, availability, performance or which other quality item. These requirements can impact the technical configuration, like high redundant configuration or shadow/mirror configuration or on software or hardware level mirrors. The requirements are defined by the user and documented the implementation-, project- or service level manager. In EA the solution for these requirements are identifiable by aggregated configurations, artifacts or special connections like synchronization or replication links. (see appendix 10 for ISO 25010 product quality)

Changes initiated by infrastructure:

4. **New platform releases**
   New platform releases and updates requiring new infrastructure are showing similar effects as new functional requirements. New functional requirements are initiated by the user and new platform releases can be initiated by the supplier also. Most of the software suppliers supports the two most recent releases only. In case a company decides not to install upgrades, they will get in an “out of support” situation. The effects are quite similar, the same as the effects in EA.

5. **Out of support of equipment**
   In case hardware gets out of support and needs to be replaced, often the new hardware is only supported by the latest versions of operating systems (OS) and drivers. In some cases new version OS can have impact on the application landscape because the new OS is not supported by the version of application. We identify here a driver that new hardware can initiate new software (versions). With EA these “total” upgrades are identified by checking the versions in EA with the required versions of the various suppliers.

6. **New technologies and developments**
   New technologies and developments can initiate changes is infrastructure and EA. For example a redundant SQL environment are in the past build with a cluster of two SQL server and a shared storage. With SQL 2012 the feature “AlwaysOn” or Windows Server Failover Clustering (WSFC) became available. This feature creates more possibilities for resilience and distributing over more locations. So a release update can have impact on the quality criteria and impact requires new hardware configurations.
   Another example is the use of tablets. The use of tablets in a professional environments can impact the whole infrastructure. For example, het Wi-Fi network needs to be capable of supporting these “walking around” devices, but authentication and security are points of attention. And last but not least, the user required Apps for accessing his data.

All new technologies are identifiable in EA by changing environments. This can be at business need level, but also at application and infrastructure level.

Independent the source of the changing requirements, Application changes can initiate Infrastructure changes and vice versa.

4.4 How to identify impact on the Infrastructure Management Scope

When a IT infrastructure is designed according a special design, the IT team must be capable of maintaining that design. With the design you can think e.g. of the type and version OS, the type of database, or the structure of replication to realize quality requirements. Quality requirements are most of the time solved by special configurations like replicated databases, journaling systems, redundant configurations and so on. We can conclude that measurement to cover quality issues can be visualized with EA, however all details about the design may need additional documentation (Paauwe & Paauwe Wijnands, 2010)

The relation to used platforms like system software and additional tooling can be visualized with the design of the infrastructure. However, when components are defined as combined device, overview is missing (Figure 31)

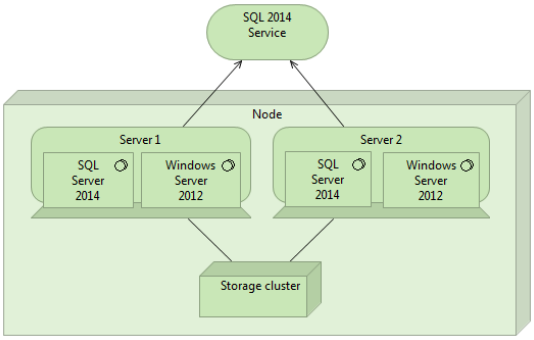


Fig. 31 Aggregated device reproduction

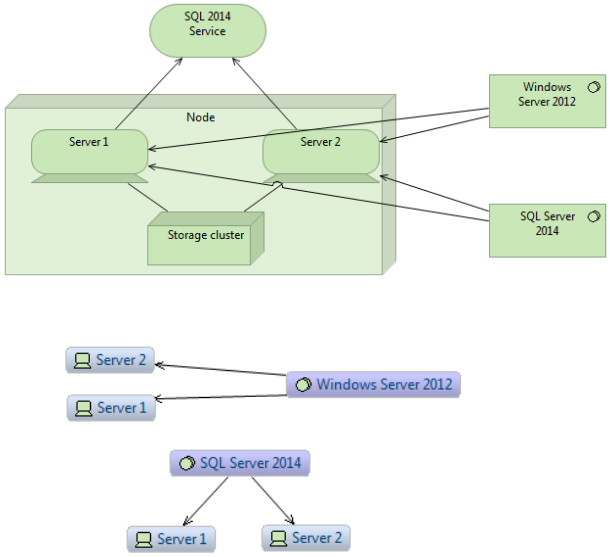


Fig. 32 Used By relation reproduction

In case the operating system or any other specification is placed outside the device and is centralized, you can visualize the total number of relations like in figure 32. With a complex infrastructure there is a risk the design gets messy due to the amount of relations, but this is a personal choice how to register these relations. An overview is now created about the use of SQL and Windows 2012 in this case. Of course this information should be available in the CMDB and in the software monitoring tool also, but now it is related to EA.

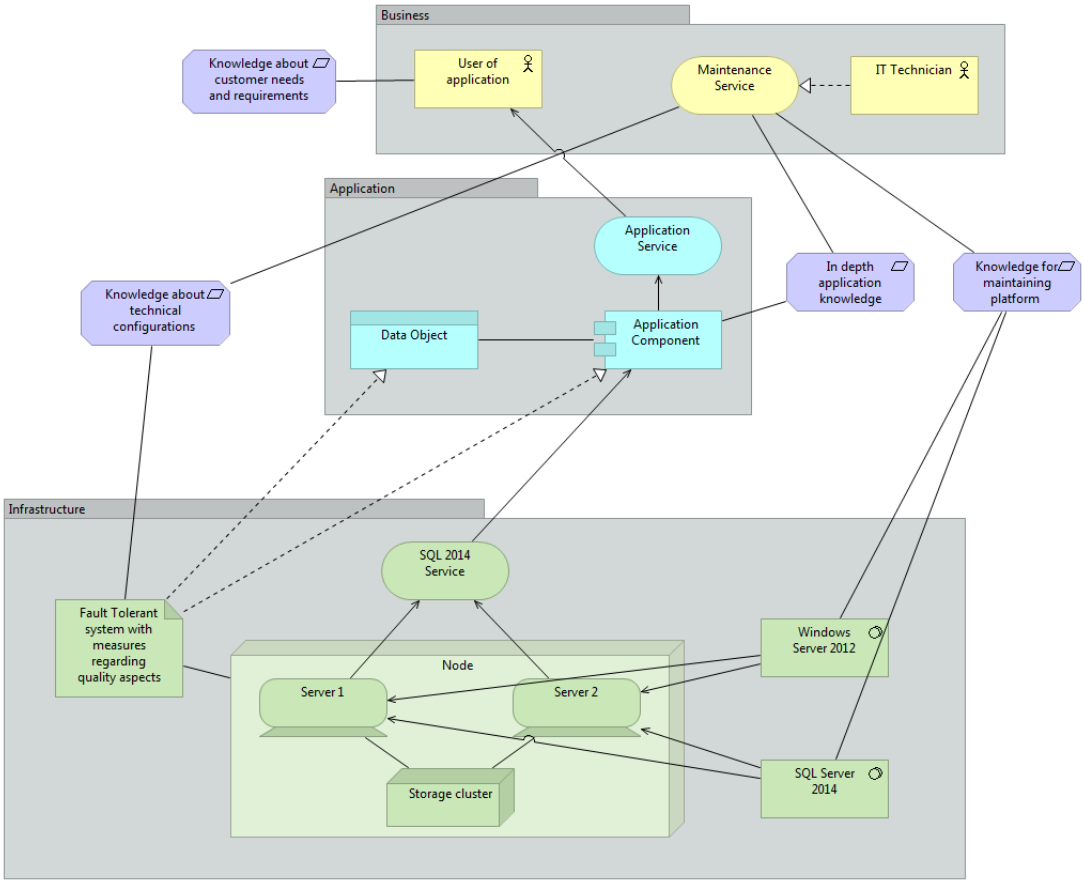


Fig. 33 Defining requirements for installation and maintenance

A requirement (as defined in ArchiMate) is defined as a statement of need that must be realized by a system. But a requirement can also be used to describe the need for something which is required to produce a product or execute an activity. This is an essential departure from the standard ArchiMate Requirement definition. This departure is made to fill this type of requirement the ArchiMate definitions. In figure 33 the required knowledge to deliver a maintenance service is visualized with a “requirement”. Without the required knowledge or without enough knowledge, the “maintenance service” will be unavailable with enough quality. We also identified the four types of required knowledge in this architecture.

The three items in the PPK model (figure 30) are the items architectural changes can have impact on. We have discussed the sources of architectural changes and on which part this impacts EA. We also discussed the four types of required knowledge (figure 29)and the way we can identify the need of this knowledge.

The relation between the type of change and the impact to the infrastructure is visualized in Table 2. This gives insight where managements attentions is required. We can conclude that there is a large relation between product and knowledge.

Relation type of change to PPK	People	Product	Knowledge
New functional requirements and updates			
Change in intensity of application use			
Change of quality requirements			
New platform releases			
Out of support of equipment			
New technologies and developments			

Large Impact
Medium Impact
Small Impact

Table 2 Relation type of change to PPK

The relation to the type of knowledge is showed below. This is to know which type of change impacting the type of required knowledge.

Relation changes to required type of knowledge	Customer needs	In depth Application	Technical Configuration	Maintaining Platform
New functional requirements and updates				
Change in intensity of application use				
Change of quality requirements				
New platform releases				
Out of support of equipment				
New technologies and developments				

Table 3 Relation changes to required type of knowledge

Large Impact
Medium Impact
Small Impact

We can identify that Business driven changes require Business understanding an IT driven changes do hardly. Quality requirements impact the required knowledge on all areas because of the impact and the wide scope of quality requirements

The changes are identifiable in EA according the description in chapter 4.3. Below the impact on the PPK criteria and the required knowledge type are identified

1. **New functional requirements and updates**
   New functionality in the form of new or changing applications is having impact on the product required to deliver the service, but also on the required knowledge to support and maintain the environment. It is having medium impact on the people aspect because most of the resources are required only during implementation. The types of required knowledge are in depth application knowledge and customer understanding to do the after implementation support.

2. **Change in intensity of application use**
   In case the use of an application is increasing, the underlying infrastructure needs to be increased and parameters needs to be changed. It can also mean licenses need to be increased. An increase of user support requests can be expected, so enough resources to cover this should be available. When an increase of usage occurs, it is important to have more insight to the user needs.

3. **Change of quality requirements.**
   Quality specifications can be very wide. Most of the time is has impact on the product (infrastructure) because measures to guarantee these quality requirements need to be implemented. This could be availability, fault tolerance, performance. The configuration to support this extra quality need to be supported by the infrastructure team, so they need to cover the required knowledge. Depending on the measures to cover the required quality, it can have impact of all types of knowledge.

4. **New platform releases**
   New releases of platforms can have impact on the application, but also on the underlying infrastructure. New releases often provides new functionality requiring new equipment. Change of platforms have impact on all PPK items: You have to guarantee enough knowledge about the platform, but also enough people mastering this knowledge and of course the platform impact the product. The required knowledge is mainly restricted to the platform usage and less the extra new required hardware

5. **Out of support of equipment**
   Out of support hardware needs to be replaced to be able to deliver the required service levels. Most of the time new hardware will be installed with new platforms, or a combination change will be performed. It has always impact on the product, think of migration time, but also a better performance. Due to new technology, new configurations are made, which has impact on the required knowledge.

6. **New technologies and developments**
   New technologies are initiated most of the time from infrastructure view, but once available very fast adapted by the business. Think of the smartphone and the tablet. Once available IT departments were hardly capable in supporting this equipment. The impact is most product and knowledge related. The required knowledge is applicable for all types, where in the startup time only general business requirements were applicable.

With above information it should be possible to create insight in the new infrastructure management scope and calculate the required resource increase and knowledge demand. In case of certification requirements, the above information can be used to define the knowledge needs.

5. Case study

This case study is used to determine the impact of a major application change on the IT infrastructure management scope. The impact is determined on the people, products and required knowledge of the team to deliver the service. In this chapter the business, application and technical architecture are reviewed. The impact on the infrastructure is determined with use of the conceptual model. The results of the case study are evaluated with a master plan created to prepare the infrastructure services and environment for the new EHR to validate the conceptual model.

5.1 The proposed EA

The case study is executed at CWZ in Nijmegen where the Board of Directors is intending to purchase a 4th generation EHR. In current versions of EHR's is supporting the activities of the MD's. A 4th generation EHR is using artificial intelligence and creates possibilities to advice the MD with diagnoses and treatment proposals. Peripherals like sphygmomanometer and heartbeat meter are now only on request extracting information to the digital dossier. With an 4th generation EHR these equipment can continues send information to the EHR. With artificial intelligence the EHR can predict an cardiac arrest before it occurs. It can sent an alarm to the MD to prevent the occurrence.
The first operational 4th generation EHR's are expected in 2015. With a future 5th generation EHR, it is not assisting the MD with the diagnose and treatment, but it will coach and train the MD with his diagnose and treatments and will value the performance compared to his colleagues and the market.
But now we are focused on the relation EA and IT infrastructure management during the preparation of a 4th generation EHR.

A domain structure is defined for the processes of the hospital. Five domains are identified.
Domain 1
Capacity without specific reservation:

- Information Management
- ICT Infrastructure Management
- Finance & Control
- Patient Information

Domain 2
Capacity with specific reservation

- Housing department
- Personal Planning
- Capacity Planning
- Expenditure Planning

Domain 3
Patients Logistics

Domain 4
Registration, invoicing and collection

Domain 5
Medical care domain
These domains represent the primary and secondary processes. This is the environment touched by the implementation of a new EHR. The intended EHR Epic is one of the most advanced medical systems available, however is restrict itself to the medical part of the primary and secondary processes. For the not medical processes other solutions have to be selected.

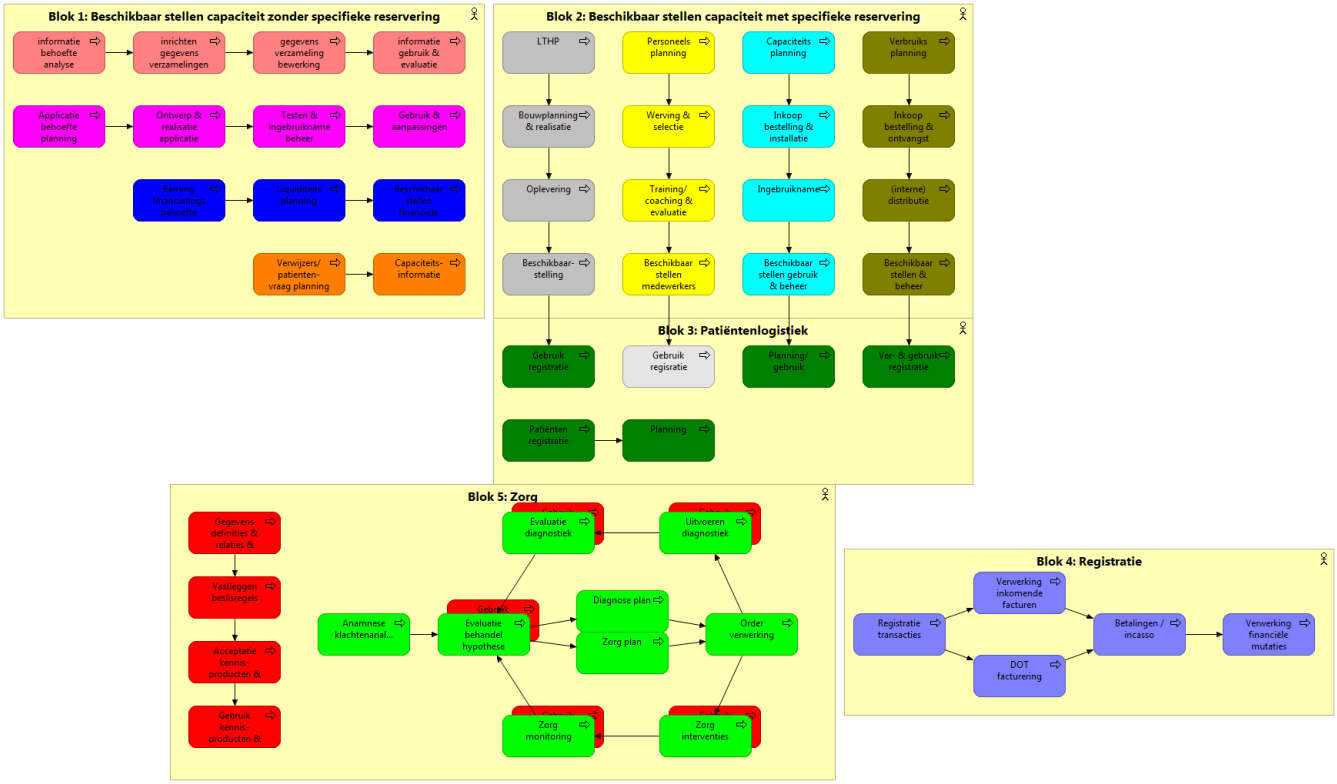


Fig. 34 Healthcare Domain Structure

The application landscape is extended with the new EHR applications as shown in appendix 2

We will discuss the multiple layer model first and after that the infrastructure layer will be discussed to identify more details impacting the service delivery
When we look at the EA in the new situation, we can identify the new required knowledge.

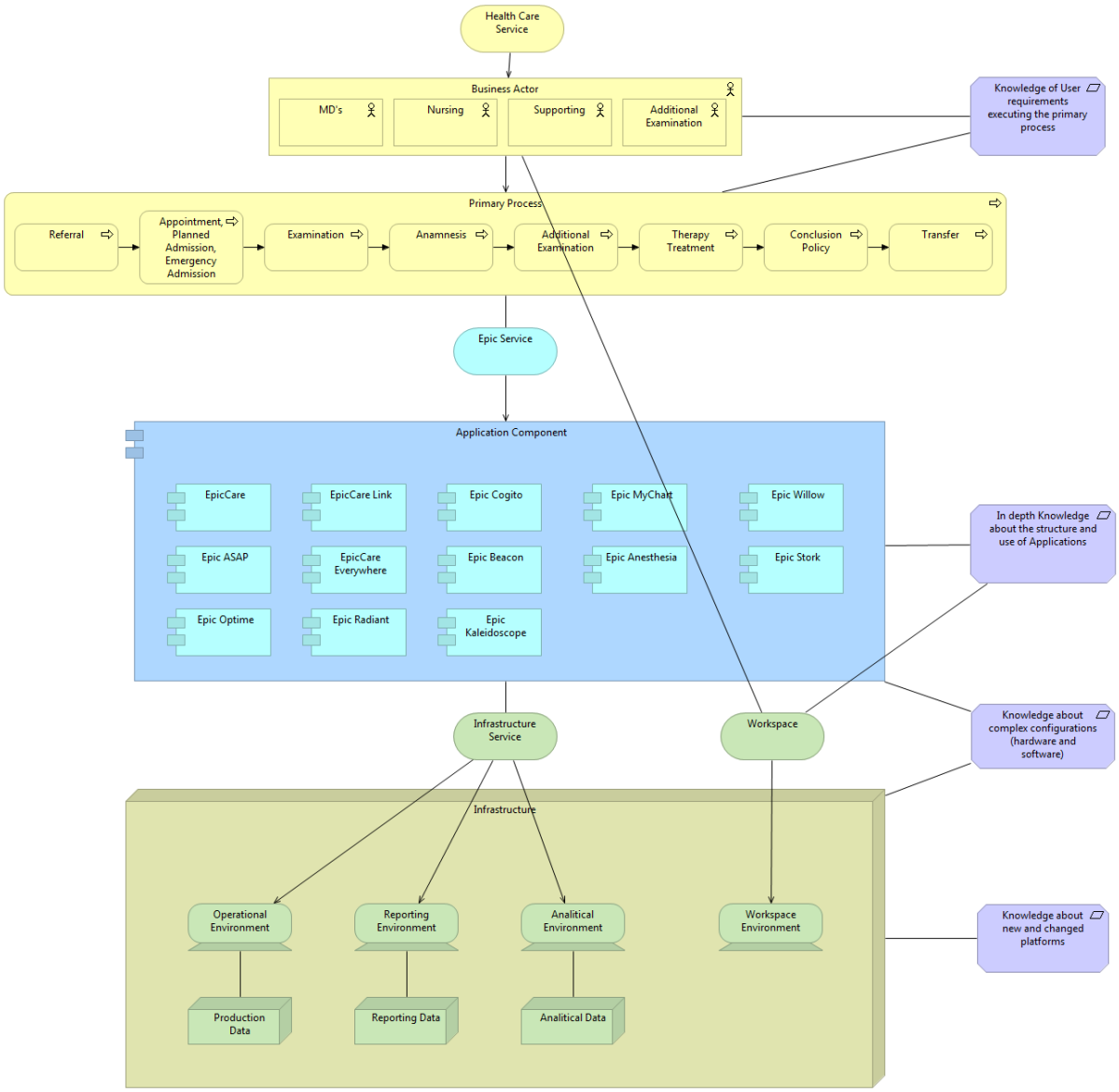


Fig 35 Epic in EA perspective with knowledge requirements.

From user perspective is support required for the total of IT activities, so besides knowledge about the infrastructure the user is also requiring application knowledge and the way how he has to use the application performing the primary process.

From business perspective the user is requiring knowledge about his needs and how to use the application and the IT environment to be able to use the application like the workspace facility.
From Application perspective knowledge is required to Use, Maintain and Customize the application. In case in or between applications complex configurations are present, in depth knowledge about these configurations is required.

From Infrastructure perspective platform knowledge , complex configuration knowledge and some application knowledge for e.g. workspace is required.

5.2 Proposed Infrastructure Architecture

The new required infrastructure needed for the new EHR can be based on several Platforms and designs. The supplier is not giving a rating to the possible platform options, but is only stating they support the mentions platforms and guarantee operational quality and performance.
For the most important components the possible choices are showed in appendix 6

We have seen in EA the platforms used within CWZ.
For Operating Systems for the backend Windows Server and Red Hat Enterprise Linux are used. The virtualization layer is based on VMware.
For workstations, currently XP is in use with mostly Internet Explorer 8, but an upgrade is planned and the workstation platform will be Microsoft based with Citrix desktop combined with XenApp virtualization. For browser Microsoft Internet Explorer is preferred.
The used database platforms are Oracle and MSSQL. Due to costs and developments on the availability of MSSQL, more and more applications are migrated to MSSQL and CWZ plans to leave the Oracle Database Platform.

For the proposed designs, Epic guarantees optimal availability, data integrity and recoverability they still propose multiple designs. The most important differences in designs is the location of the components and the way redundancy and replication is arranged. The technical design in appendix 7 is currently the most preferred by the CWZ technical architect due to minimal hardware investments.

The chosen option of the Epic infrastructure in analyzed together with the platform options. An ArchiMate picture of the proposed configuration is shown in figure 36.

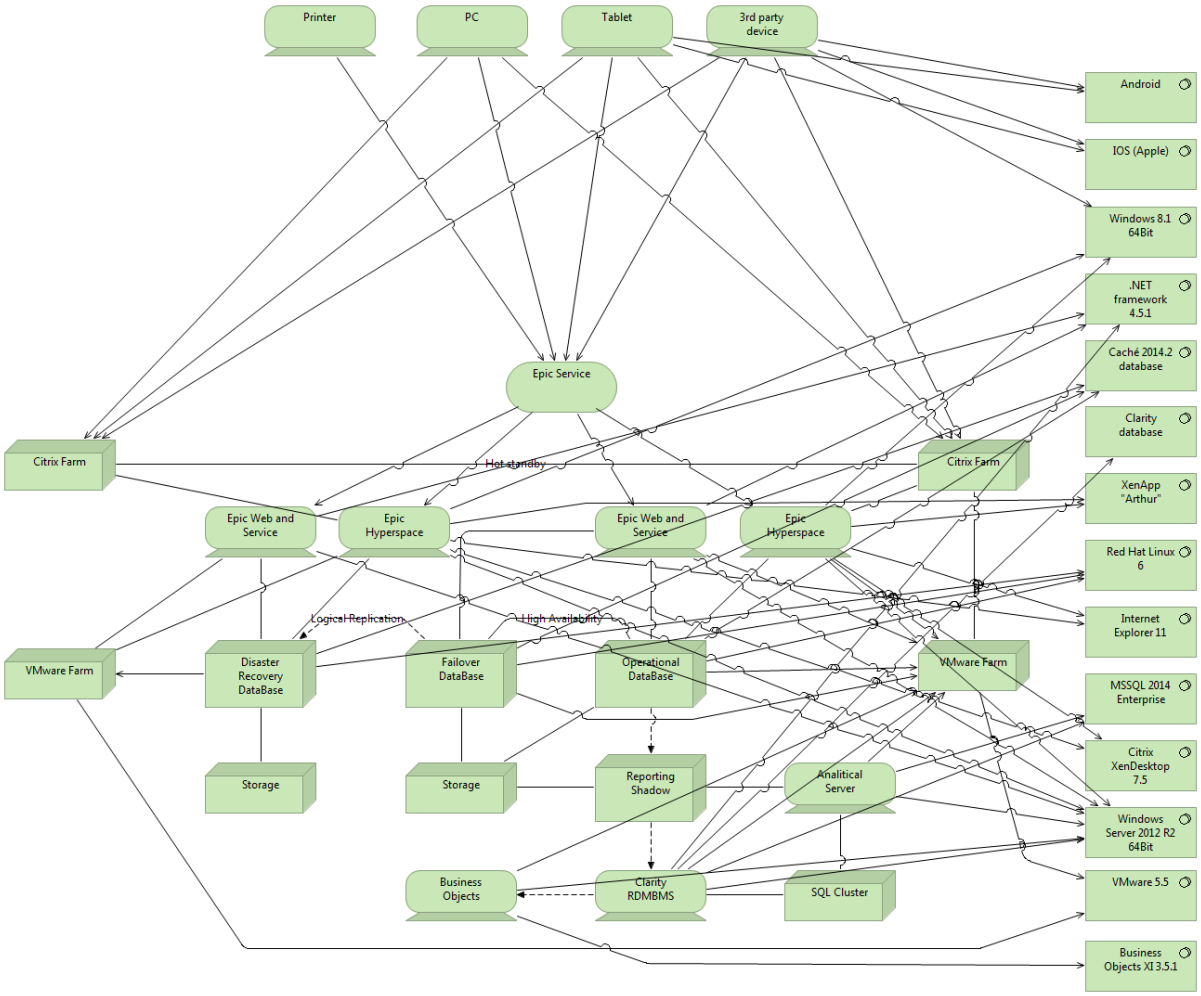


Fig. 36 Epic infrastructure with proposed platform choice.

We see in the big middle the Epic infrastructure. At the top the types of workstations and at the right all the chosen platform options.
In the conceptual model we defined the items indicating important impact of the Infrastructure Management scope. With a project implementing a new ERP or in this case a new EHR system all items can be identified.

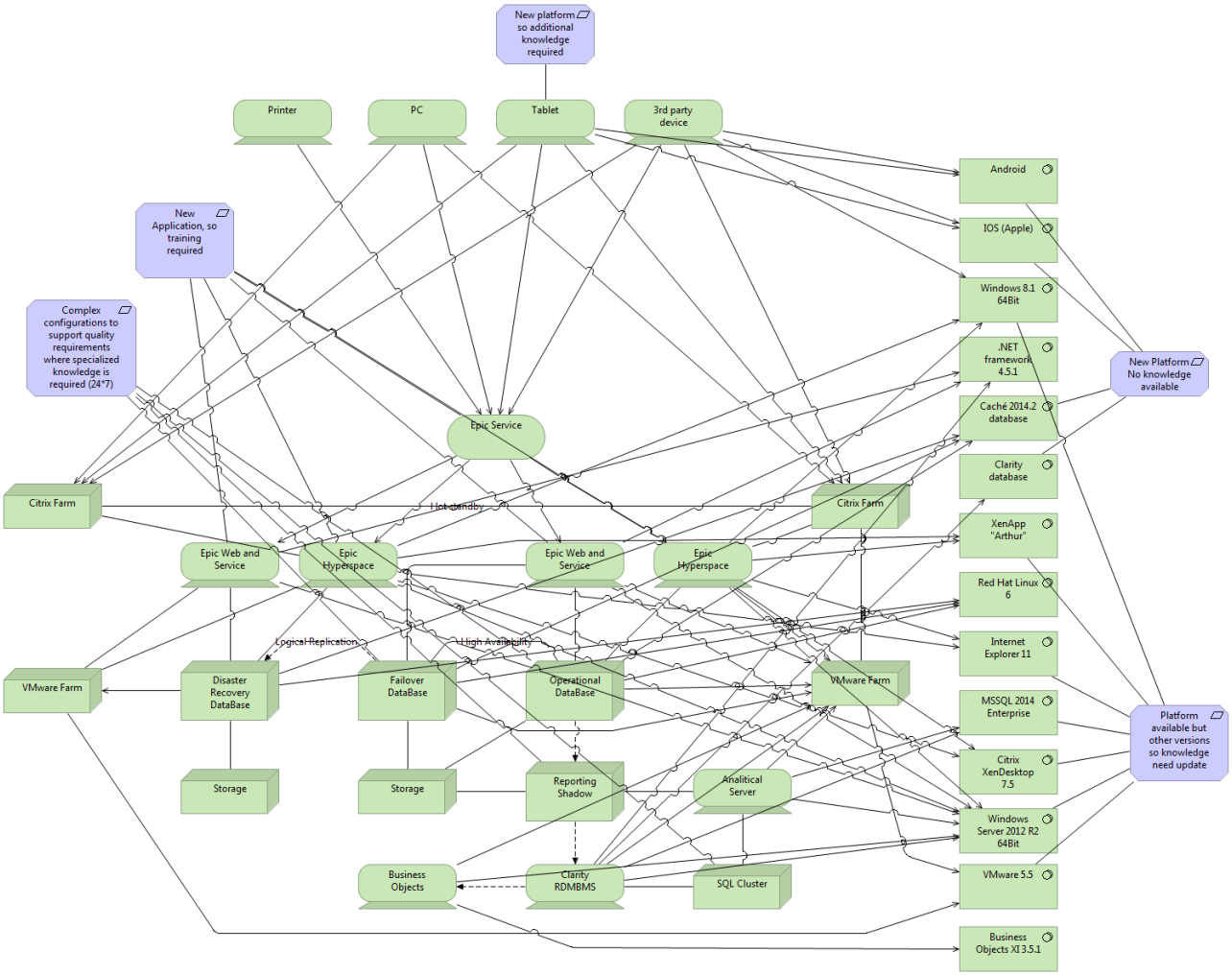


Fig 37 Epic Infrastructure with requirements.

5.3 Results of case

We identified the following signals from EA to identify infrastructural Management changes: We identified rigorous changes in the application landscape and another way of working for the health care provider. The whole application landscape will be changed so on application and business support the infrastructure management scope is changing. In figure 37 we identified new and upgraded hard- and software platforms and complex configurations to cover quality requirements and interfacing between applications.
And we identified the professional use of tablets.

1. **New functional requirements and updates**
   With the implementation of a new EHR, the major part of the application landscape is changing. The business processes are harmonized to one of the standard Epic processes. This means for the application team and the super users that they need to be trained to maintain the new environment. All communications from and to other applications is changing, so besides migration, knowledge about the communication is required . For the user the way of working and the application is changing. This gives an extra load and required knowledge at the IT helpdesk.

2. **Change in intensity of application use**
   Due to the implementation of the new EHR, there is no increase of usage apart from the current digitalization growth and a more intense use. So licenses will be comparable with the past, but the use will be more intense. The impact on personnel, the product and required knowledge will be minimal.

3. **Change of quality requirements.**
   Due to a more intense use of IT facilities with the implementation of the EHR other quality requirements are required. The application is required in a 24*7 schedule. Data security, Fault Tolerance, Recoverability and other quality criteria are required by todays applications. The technical architecture is designed to facilitate the required quality measures. The impact on the infrastructure could be quite large. Redundant systems with hot stand-by failover requires more investments than more simple configurations. The configurations to deliver the required quality criteria require in depth knowledge to understand and maintain these configuration.

4. **New platform releases**
   The EHR applications requires new platforms, but the back-end infrastructure needs also to be upgraded to facilitate the new platforms. Training and certification is advisable to ensure proper installation and maintenance. User questions about the use of the new version has impact on the IT organization, Helpdesk and specialists to give proper answers. It can have also impact on the product because new platforms require often new hardware configurations.

5. **Out of support of equipment**
   Not applicable for this installation

6. **New technologies and developments**
   With the new HER new technologies are used like now back-end equipment, but also tablets as portable devices. A more intense use of medical peripherals is established. This has quite an impact on the infrastructure because until now there was no way to manage tablets. The Wi-Fi needs to allow roaming users so they can walk around without packet-loss. Also the back-end configurations need intensive knowledge to ensure proper operations. The required knowledge is in depth knowledge about structures and configurations.
   Same of the configurations like data replications and building the data repository is technical application related.

The analyze results in a proposal with the following actions:

Product:
The product required for the delivery of the functioning functionality is replaced by a total new environment. The implementation of Epic has impact on the current infrastructure which needs upgrades to be able to host the new application. All connections to other applications need to be reviewed and reprogrammed. User support will be increased with support for new functionality

People:
With the gathered information a plan can be developed (see appendix 11) to expand the team. Extra expertise to deliver the service for the new platforms and extra resources for platforms where the availability is extended to 24*7 support. The Epic Staffing guide for the technical team (2012) is used for guide to create the resource plan. The aggregated resource plan is shown in table 4 and 5

Epic technical support:	FTE
Environment Manager	1
Data Exchange	2
DMZ	0,5
Linux	1
Windows 1/2 win 1/2 citrix	1
Sql	1
Caché en Clarity	1
Availability workspace	1
Mobile devices	1
Total	9,5

Table 4. Extra resources for supporting Epic

	FTE
Current team size	40,5
Epic Technical support	9,5
Epic Application Management	11
Standby	2
Total	63

Table 5. New infrastructure team size

Knowledge:
The technical team needs to be trained to handle the platforms and the measures to fulfil the quality criteria. Both the technical and application team need to be trained for special configurations and connections.
The recent years there was no attention to training and certification. Epic however requires engineers maintaining a platform who are certified by the supplier. (Epic Systems Corporation, 2012) With the relations of the requirements from figure 37 and in more detail appendix 9, an overview of changes in platforms can be created

Platform	Versions in use	Versions required	Training required
IOS	N/A	Recent	
Android	N/A	Recent	
. NET	Version 1 to 4.5	4.5.1	
XenApp	Version 4.5	“Arthur”	Yes
XenServer	Version 6.0 going to 6.1	N/A	Yes
XenDesktop	Version 5.6	7.5	Yes
App-V	Version 4.5 sp2	N/A	Yes
Red Hat Enterprise Linux	Version 6.x	6	
MS SQL Server	2000,2003,2005 and 2008R2	2014	Yes
Windows Desktop	XP and W7	W8.1	Yes
Windows Server	All versions 2000 to 2008R2	2012	Yes
VMware ESX	Version 4.1 going to 5.1	5.5	
Business Objects	Version 8 and 11(XI)	XI 3.51	
Caché	N/A	2014	Yes
Clarity	N/A	TBD	Yes

Table 6 Software and Database versions regarding Epic

The complex configurations are very critical. The most simple is the replication in the SQL 2014 cluster, however the possibilities with SQL 2012 and 2014 are having much more facilities then the old SQL 2003 and 2008. Without this new knowledge the reliability of the database can be harmed and in case of a failure wrong actions can be deployed. With the replication of the Caché database on-line redundancy of the production database is created. Without enough knowledge the process cannot be checked and this could have impact on resilience, availability and performance. So it is very important to be aware of difficult configurations.

Referring to the conceptual model, all four type of knowledge are required for delivering the functioning functionality and with that influencing the scope of IT management

- Knowledge about changing customer needs and requirements with the use of Epic
- In depth application knowledge about the use and maintenance of Epic
- Knowledge for maintaining new and updated platforms required for Epic
- Knowledge about complex technical configurations to guarantee the required quality criteria and communications

An inventory has to be executed for the knowledge status of the team members and to create an education plan for additional training and certification.

5.4 Results compared with Master Plan ICT

Last year a master plan ICT (Klein & Appel, 2013) is created within CWZ. This plan described the impact of the EHR implementation on the IT organization and how the preparation must be accomplished.

Within the master plan an action plan was created to upgrade the infrastructure to be able to facilitate the hosting of the new EHR. Comparable with the PPK model, this is defined to upgrade the product to the required standards.

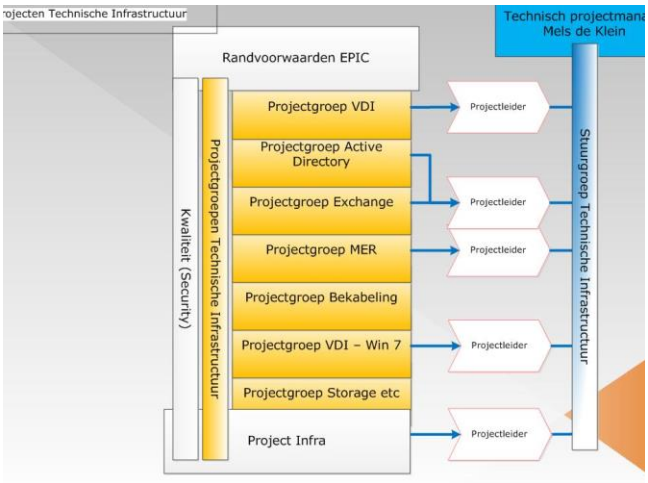


Fig. 38 Defined projects to upgrade Infrastructure

For the required resources for the EHR installation a resource plan was developed. Besides the EHR, a couple of extra proposals for applications are embedded is this plan, so it is only partly comparable with the result in chapter 5.3

Functie Omschrijving	**FTE begroot**	**FTE FPP**
Huidige IBS	32,94	32,94
FA beheer (over van IM)		12,00
Applicatiebeheer – Sharepoint		2,0
Applicatiebeheer – Link		1,0
Projecten		10,00
Epic beheer: • Netwerkbeheer • Systeembeheer • Applicatiebeheer • Databasebeheer		9,50
24 uurs ondersteuning		2,00
Pink en VCD: • Systeembeheer • Applicatiebeheer		3,50
Totaal IBS	**32,94**	
Totaal gewenst 2013 IBS		**72,94**

Table 7. Infrastructure resource planning

6 of the 10 FTE project resources are for a period of two years, where after these need to be evaluated because of the project quantity.

For training a schedule is created with educations. Most of the training tracks are built of a set of trainings of five days, so a MCSE training is built of six courses of five days.

Afdeling	Training	dagen	Training prijs
Helpdesk	ITIL/ISM foundation	3 dagen	€ 2.500
Proces manager	ISM Service Management	7 dagen	€ 5.000
	Prince 2 found & Prac	5 dagen	€ 5.000
Netwerk	Cisco CCNP	30 dagen	€ 17.000
Systeembeheer	Microsoft MCSE (op specialisatie)	30 dagen	€ 17.000
	VMware	15 dagen	€ 10.000
	Citrix	15 dagen	€ 10.000
	Linux RHCE	30 dagen	€ 17.000
Database beheer	Microsoft MCSE SQL	30 dagen	€ 17.000
	Oracle	15 dagen	€ 10.000

Table 8. Training options and pricing per employee

The relation of the courses to the required changes in platforms is not made due to lack of the relation to it.

The results of the case in chapter 5.3 are comparable to the results of the master plan.
In the case however more details are available to define the action plan.
For the product part, the master plan is giving a detailed project overview with is based on comparable information as gathered using EA.
For the people part the proposals are also comparable only in the master plan the increase of resources is based on abdomen touch and lucky guess. The figures used in appendix 11 are based on EA and very careful determined.
The plan for training in the case is detailed, the master plan however is only giving an overview of possible training and certification tracks. The other types of required knowledge are not mentioned in the master plan.

With this we can assume the results of the thesis research is giving more detailed background information to create a migration plan in case of changes in the IT (application and Infrastructure) environment.

It is proven the conceptual model is providing detailed information for defining the Infrastructure Management Scope. With this information a better foundation for investments to the IT team can be made.

6. Synthesis

We identified three factors as relation between EA and ICT service delivery in figure 30.

- People
- Product
- Knowledge

Some of this Knowledge is in the heads of the people, some of the knowledge we experience as latent knowledge in the skills of the people, but most of the knowledge is documented as library when someone needs it.
The People is also the amount of resource to do all the work. This is related to the amount of systems and applications in the IT environment.
The product is the environment which is managed by the IT infrastructure team and also defined in EA

The list of changes below from chapter 4.3 is used to identify factors causing changes in the infrastructure management scope

- New functional requirements and updates
- Change in intensity of application use
- Change of quality requirements
- New platform releases
- Out of support of equipment
- New technologies and developments

With the analysis results together with the information of table 2 in chapter 4.4 an analyze on the PPK model could be performed for all indicated triggers and related changes

People
With the People item of the PPK model we have to ensure that the required amount of ICT staff is according the required for the new amount of infrastructure. The level of competence is crucial for operational excellence. When the complexity is raising and the people are not capable of maintaining this new configuration, HRM activities need to be employed to align the level of employees with the required competences.

Product
With this new configuration we may assume the new products are providing the required functionality conform required quality. However, the chosen design in appendix 7 was made on financial basis, but the supplier guarantees proper performance and resilience. It is advisable during a decision as design issues, to gather enough background information to ground this kind of fundamental decisions.

Knowledge
We have identified four types of required knowledge to be able to deliver a functioning IT functionality in figure 29 in chapter 4.2.

- Knowledge about customer needs and requirements
- In depth application knowledge
- Knowledge for maintaining platforms
- Knowledge about technical configurations

We've used the types of knowledge to identify the possible gaps.
In table 3 we related the type of knowledge to the type of change. This is important to identify the knowledge gap and be able to take the appropriate action.

The knowledge issues and requirements identified are:

- In depth application knowledge is required to install, maintain and customize the application.
- There are multiple new platform in the new configuration, so additional knowledge and certification is required.
- Lots of platforms needs to be upgraded, and therefore also the knowledge and certifications of the ICT staff.
- A couple of difficult technical configurations are identified. Knowledge about these configurations is required to be able to maintain and test these configurations.
- The user requirements can be changed due to new possibilities, changes requirements and other implementation of the processes.
- Due to increasing IT usage, sizing of the environment must be executed and quality requirements can change.
- The use of the new EHR can cause extra support requests from the user for questions and additional instructions. The IT department must be prepared for this

The tables 2 and 3 can be used to identify the impact on the application- and infrastructure team on capacity and knowledge.

The fact that the outcome of this case study is comparable with the outcome of the created master plan ICT (Klein & Appel, 2013) we can assume the models in the conceptual model are providing the required insights to redefine the Infrastructure Management Scope.

7. Conclusion and Recommendation

7.1 Conclusion

In this thesis research the possibility of defining the management scope of the IT infrastructure team (as defined in chapter 1.3) with the use of Enterprise Architecture(EA) is investigated. EA is used to define and visualize the architecture of the business, business processes, information management, application landscape, the IT infrastructure and their mutual relations.

It is hard to define the skills, capabilities and amount of resources of an IT infrastructure team to be able to deliver operational excellence for IT services. Within IT service organizations often insight about the capabilities of the own organization is hard to retrieve. It is also difficult to define the skills and competences which are required to maintain the environment.

By answering the sub questions, the answer to the main question can be given.

1. To what extent can the required knowledge areas of the infrastructure team be defined with the use of Enterprise Architecture?
   - Service delivery is depending on e.g. capacity and ability. What is the relation of the delivery scope and the capability of the team and is it possible to visualize with EA

   As we have seen in chapter 4 we can extract information about user requirements, used platforms, difficult- and customer specific configurations and required skills, competences and knowledge from EA. We can assume that these requirements must be mastered by the team or the contracting party for executing the required management and maintenance tasks. With this we can state that the skills, competences and knowledge from EA can be used to define the Infrastructure team.
   There is also a relation between the size of the infrastructure and the size of the team. It is however hard to define the size of the team with the amount of infrastructure, there is currently no arithmetical way to define this. It is depending of the complexity and design of the infrastructure and the capabilities of the individual team members. However, the size, availability and the complexity of the infrastructure and the efficiency of the team are directive to the size of the team.

2. To what extent can ArchiMate be used to visualize the scope of management, internal processes and required knowledge for the infrastructure team?
   - Is ArchiMate appropriate to support this research?

   All activities for this research regarding EA are executed and visualized with ArchiMate. ArchiMate is designed to explore EA and is capable of visualizing the relations between the EA layers as discussed in chapter 2.4. This research was focused on defining capabilities and required knowledge from EA. This is not a default feature and there is no default language notation for knowledge. However, a requirement is defined as a statement of need that must be realized by a system. (The Open Group, 2013) In this case a “requirement” can be used to symbolize a need from the IT infrastructure team

that must be delivered to be able to maintain the infrastructure environment. It is a bit improper use, but the item “requirement” has shown to be capable of displaying the knowledge and capability need.

3. To what extent can new requirements for the ICT infrastructure team be visualized using Enterprise Architecture? Can the impact on outsourced services be visualized?
   - Is it possible to use EA to define required changes on the infrastructure team and the way of sourcing?

   As shown in figure 37 and appendix 9 new requirements can be visualized with the use of EA. The impact on the infrastructure team can, together with the capabilities of the team, be used to define the ability of the infrastructure team. The size of the team is depending on more factors, see the arguments of sub question 1.
   EA nor the specification of required ability is giving direction to the way of sourcing. Changes in EA can however initiate discussions about the way of sourcing. In case of more complexity or fast growing environments, outsourcing can offer more flexibility to fulfil the required service.

Going back to the main question:

To what extent can the management scope (required capabilities and capacity) of an IT infrastructure team be defined using Enterprise Architecture.

EA can be used for defining the environment to be managed by the infrastructure team. It also can be used to define the required ability of the infrastructure team. It gives a direction to expanding the team in growing environments, but this is depending on more factors as described above at sub question 1.
EA can in case of changes in application landscape be used to determine changes in the management scope of the infrastructure team.
In cases where certification is required like Epic which demands certified engineers for the total of the Epic environments, an overview of required certifications can easily be obtained. In business critical environments and environments like banking, medical and SOX compliancy it is not unlikely certification of engineers is required by rules in the future.

EA is a method to administer architecture on different levels and their relationships. Regarding the requirements, you can define EA on the level you need. If you want to define the Infrastructure Management scope with EA, in this thesis research is proven EA is capable of doing so.

7.2 Recommendation

Setting up Architecture is very time and knowledge consuming. Setting up EA is very useful to align business demands to application landscapes to IT infrastructures. It gives possibilities to optimize the IT environments and prevent disinvesting in projects not conform to IT strategy and therefore business strategy. In case a company is working with EA it can be used to determine the impact of business changes to application landscape and the underpinning IT landscape. Now it can be used to determine the impact on the supporting IT

organization also. In case a company did not define EA, the dependencies can also be extracted from the IT architecture in forms of other documentation. In case there is no IT architecture also, the IT infrastructure management scope can only be determined on best effort.

A detailed EA is quite complex and consists of a large amount of components. The more components, the more complex EA, which is degrading the visibility. The amount of relations is even more than the amount of components. Future research can be done on optimizing the visibility of all relations in complex application and infrastructure landscapes. Pictures like appendix 3 only indicate the complexity and not the required overview of relations. The relations however reflect more information than the components them self.

8. Discussion and Reflection

8.1 Discussion

With this research I tried to motivate investments in the IT infrastructure team in case of big adjustments in the application landscape. This change in application landscape was driven by the wish to simplify the business processes to reduce costs and facilitate new developments. I (mis)used the EA to motivate necessary investments for the infrastructure team. With this research, motives are given to support these investments in adjusting the team size and the ability to deliver the required service.
What are alternative ways to fulfil in the insight of the need to invest in the infrastructure team?

Is EA the appropriate tool to visualize this “ability” and certification requirement. I (mis)used the “requirement” notification to define the knowledge and skills requirement. However EA is normally not used to define the infrastructure team capabilities in this way.

The reliability of the obtained information is depending of the quality and the detail of EA. So the quality of the information to define the Infrastructure Management Scope is depending on how EA is treated and put together. However, the way de Klein and Appel created the master plan is composed with comparable quality. Concluding EA is a tool which can be used to define the Infrastructure Management Scope, within the margins the used information is validated and with enough quality and detail.

8.2 Relfection

This thesis research was very educational to me. In the past I didn’t do anything with EA. It gave me an insight of the content of EA and the possibilities to visualize the mutual coherence. The Research Participation Project was coming up with EA related paper reviews. Within CWZ there was a program to start EA, so this was for me the trigger to make use of a natural moment and combine EA, the changing Infrastructure and the team developments to start this research.
Yes, this research gave me more insights like the PPK model in figure 30, where the infrastructure design impacts the infrastructure team. These three items, People, Product and Knowledge are manageable factors to enable the infrastructure team in performing their job.
The explanation of ability gave me more insights to what is important to manage my team and how I can provide them with more capabilities to do the job.
Working with EA was more work intensive then I expected bud it provides also more insights and details also.

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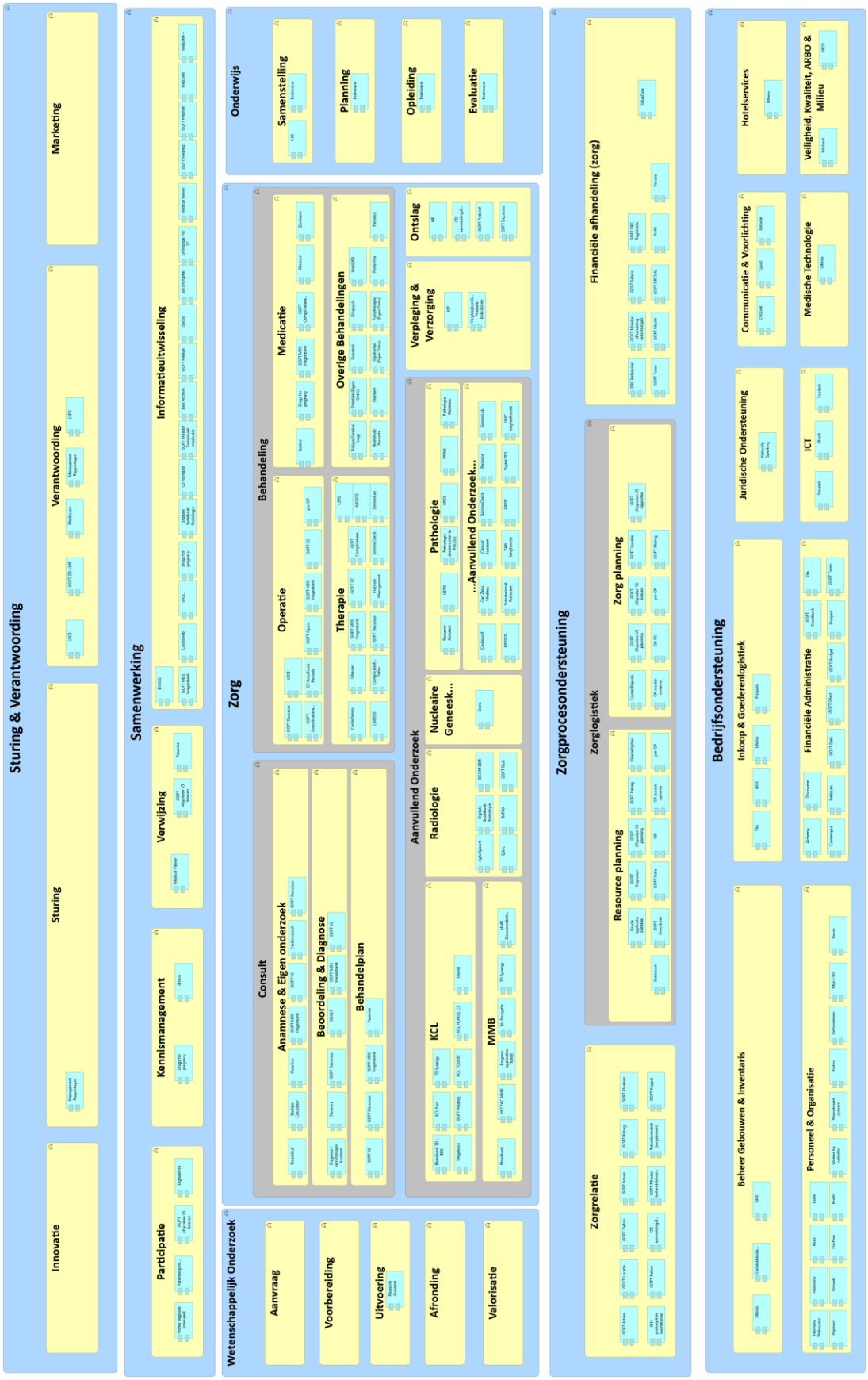
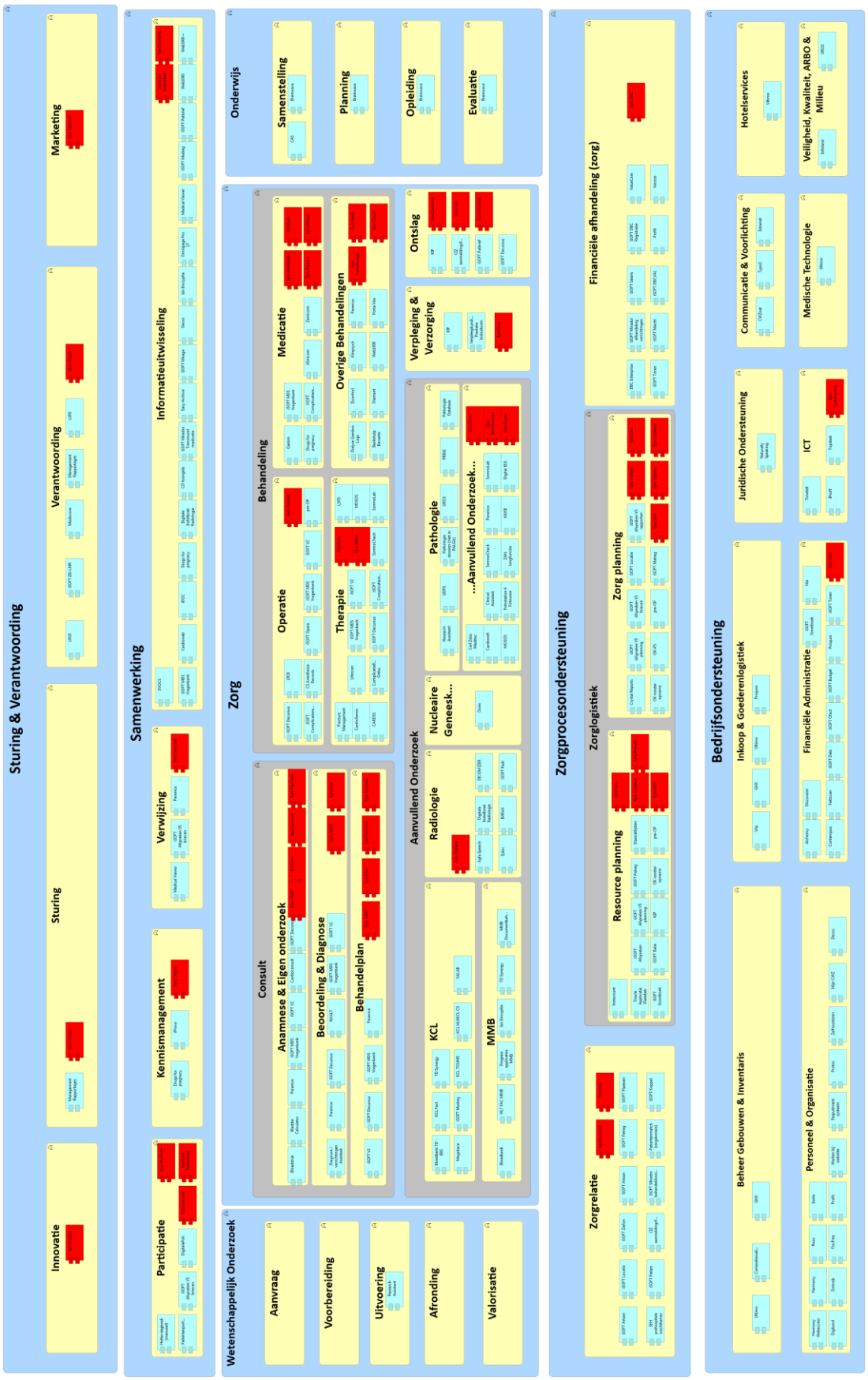
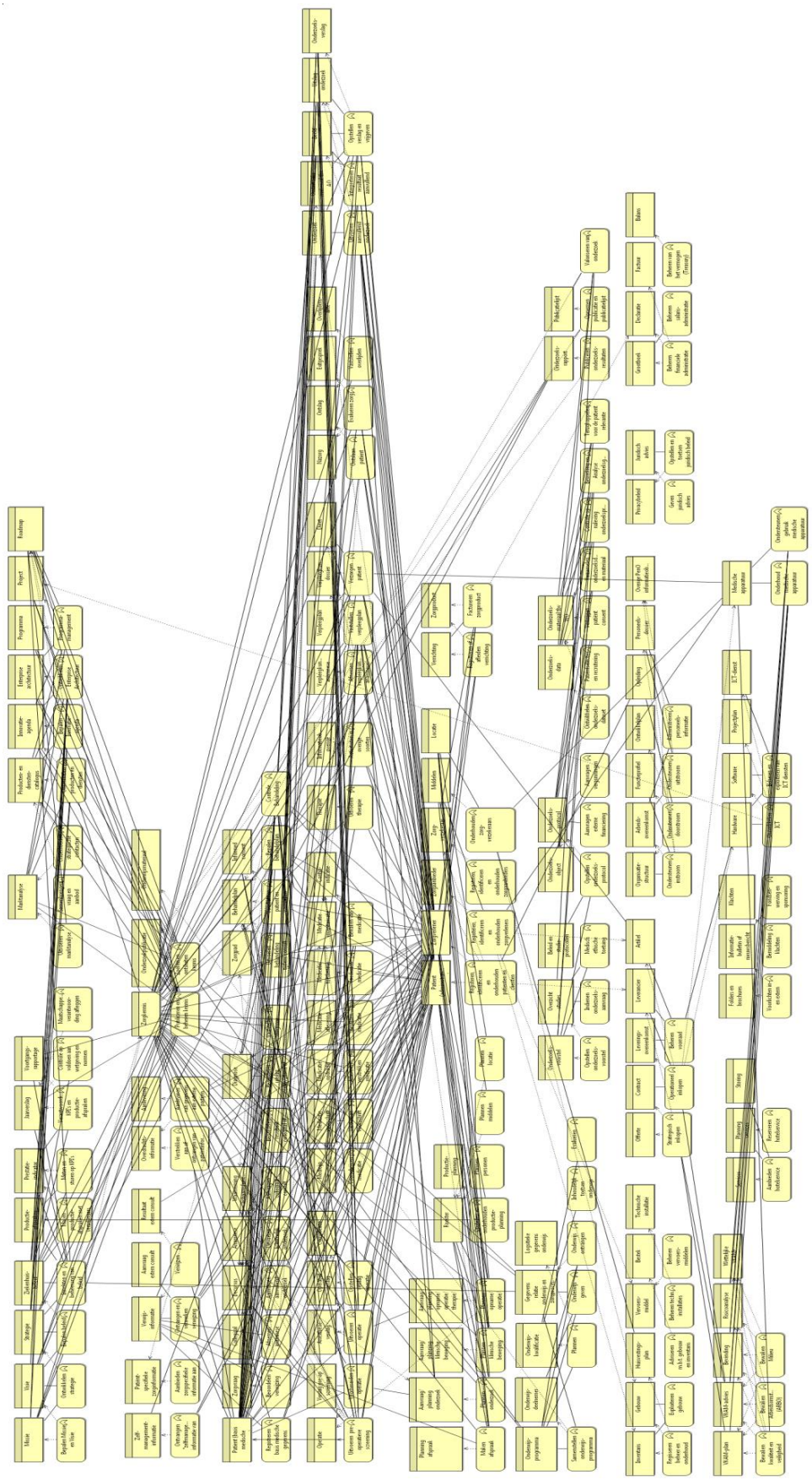
Appendix 1. AS-IS Application Landscape



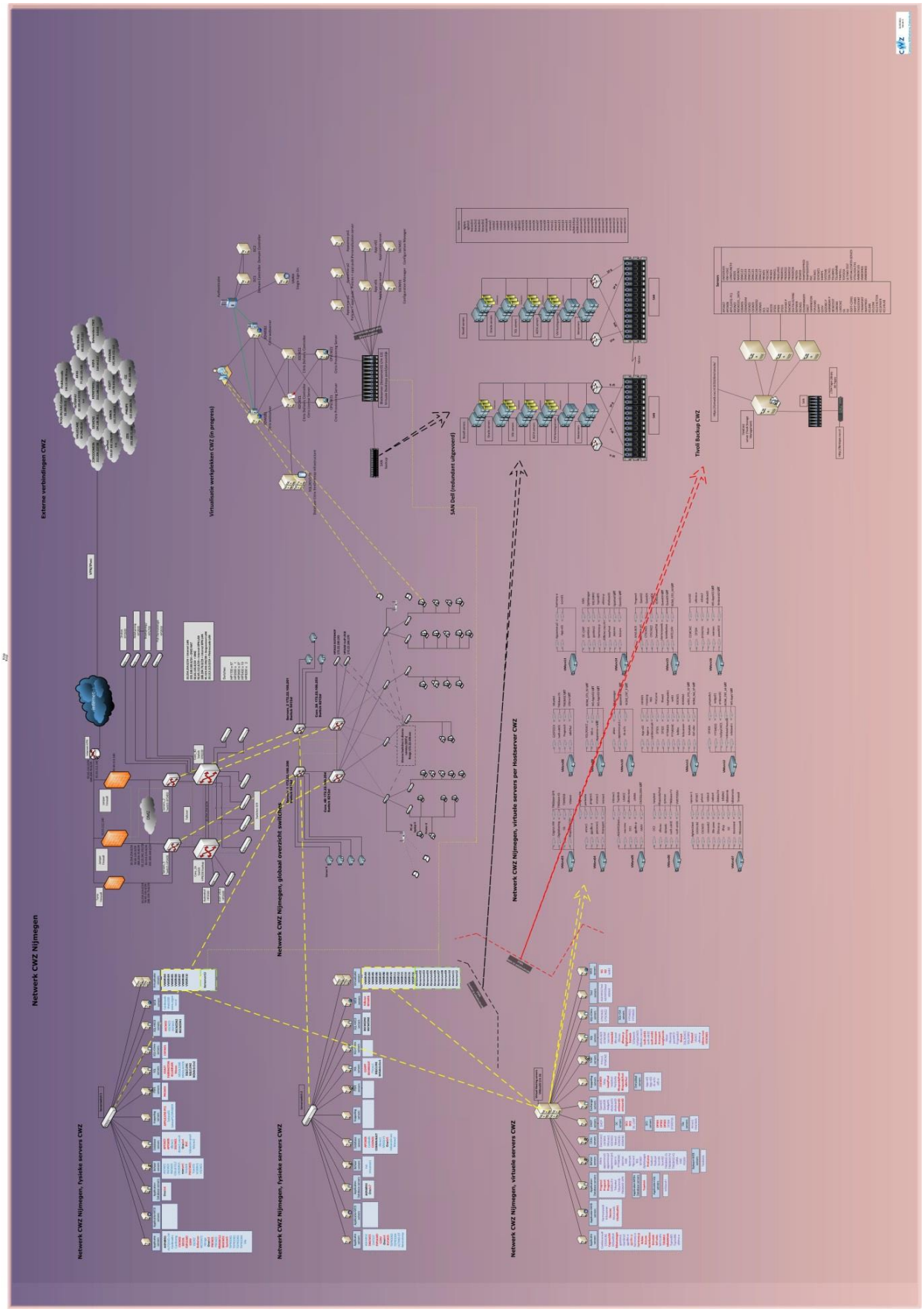
Appendix 2. TO-BE Application Landscape



Appendix 3. Logic Information Model



Appendix 4. Technical Landscape



Appendix 5. IT Department architecture

As discussed in chapter 2.2 IT processes can be defined by the six verbs. In figure A5.1 the six main IT processes are worked out with the mutual relations.

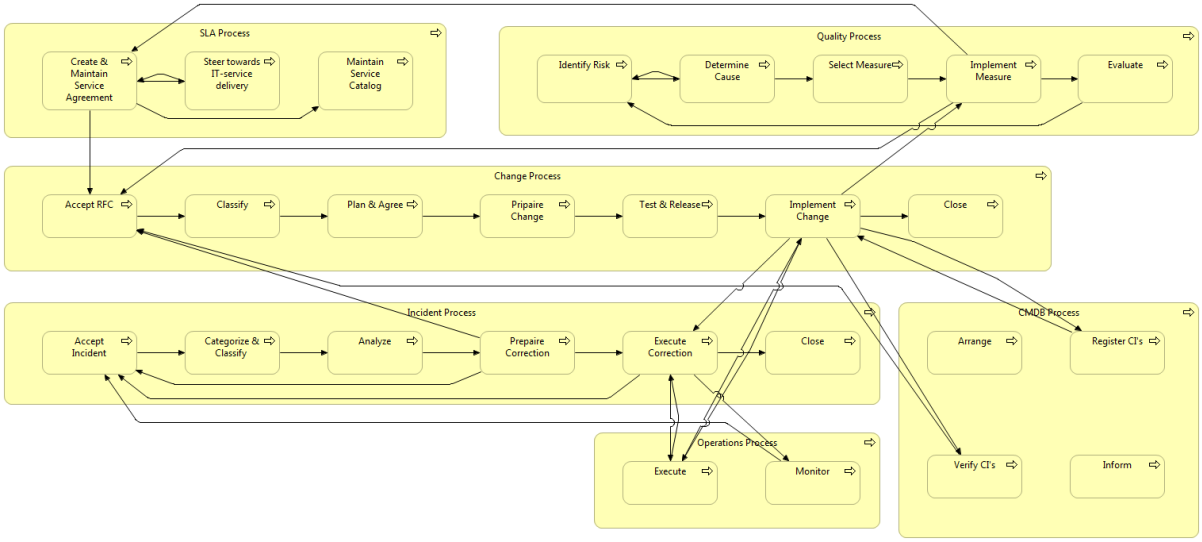


Fig. A5.1 IT ISM work processes

The processes from the IT department are comparable with the business processes for the business. This means that when you separate the IT department, an EA for the IT department can be created. This EA is focusing as if IT is managed like a business. The IT department has its own customers, the internal IT-user and besides its suppliers an extra party like the procurement department. However you can visualize IT EA and not IT related components with other colors.

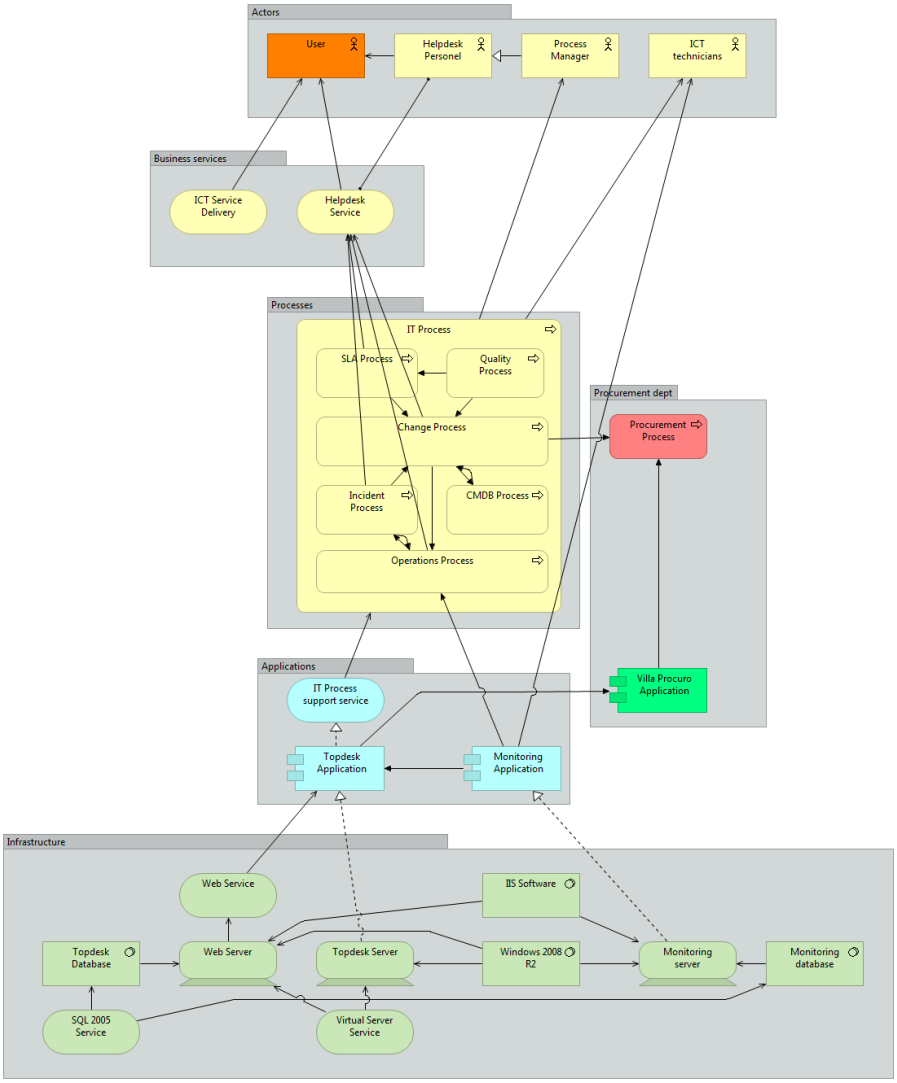


Fig. A5.2 Enterprise Architecture from the IT department

The internal IT user is now the customer. Three internal user-groups are identified:

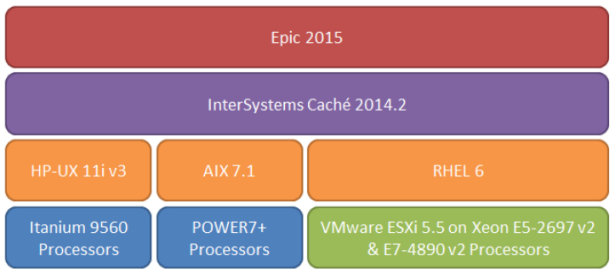
- The helpdesk as a customer support department
- The process managers to guarantee the service delivery
- The technicians as the workforce.

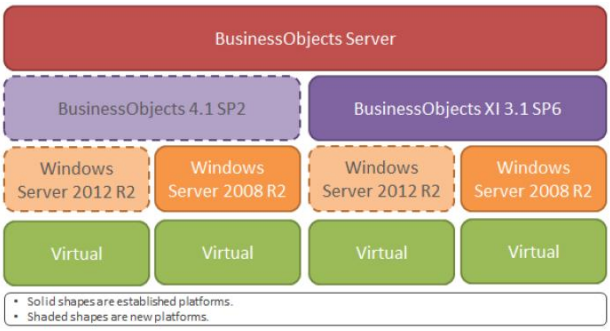
Two IT services are identified:

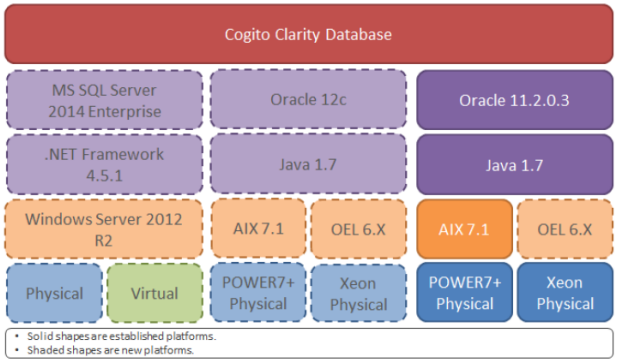
- The helpdesk service as the service to access the IT processes by the customer
- The IT service delivery as product of the IT department

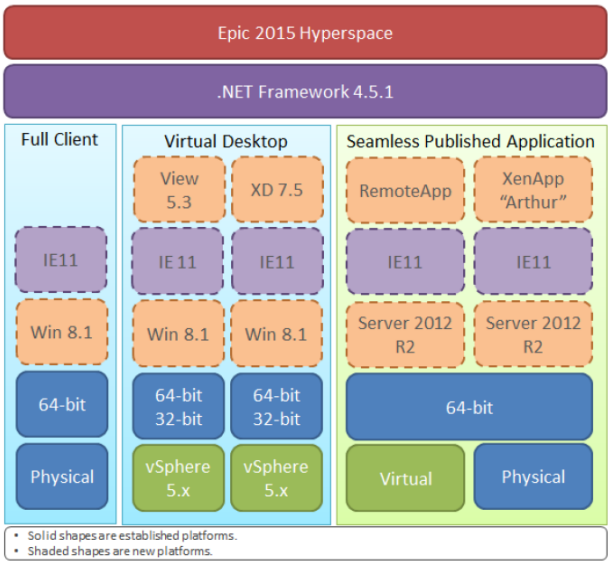
The identified programs directly assigned to IT are the helpdesk application to support the IT processes and monitoring software to monitor the health of the IT environment. The helpdesk application is for the IT department comparable with a ERP application for the business. The procurement process, as part of the change process, is linked to an application from the procurement department. This can differ by company and is depending how IT procurement is arranged. The infrastructure is comparable as other infrastructure, however in case of failure the system provides information to solve the problems en needs to be available any time.

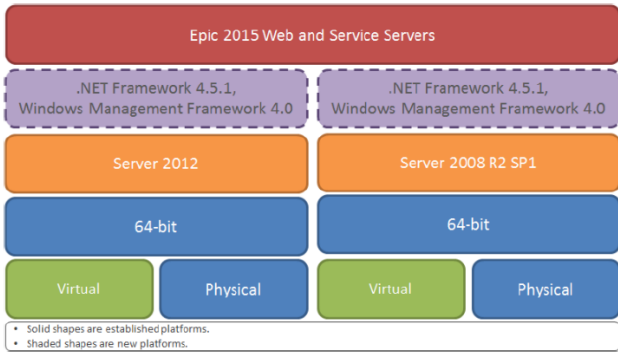
Appendix 6. Epic Infrastructure Platform Options

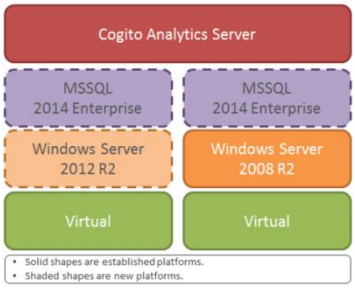




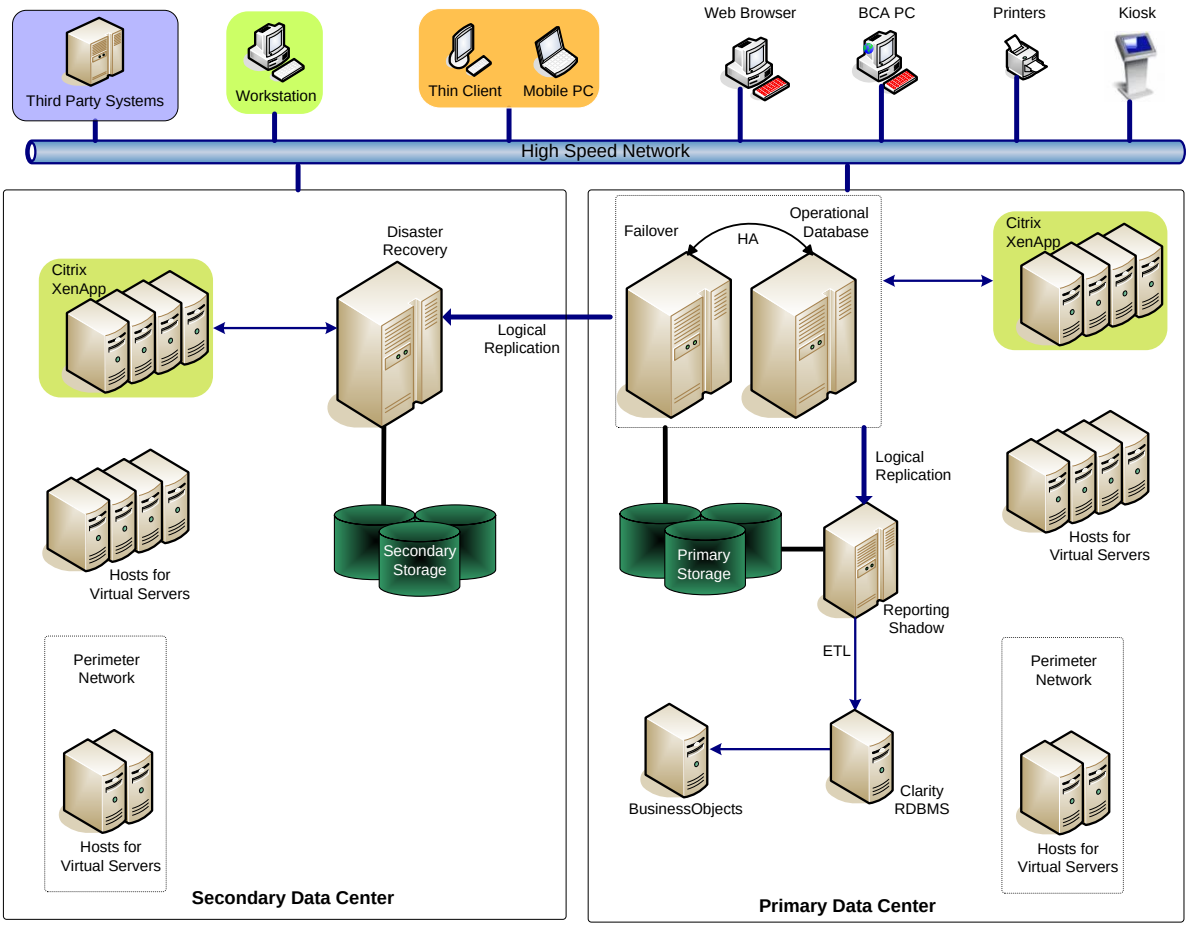




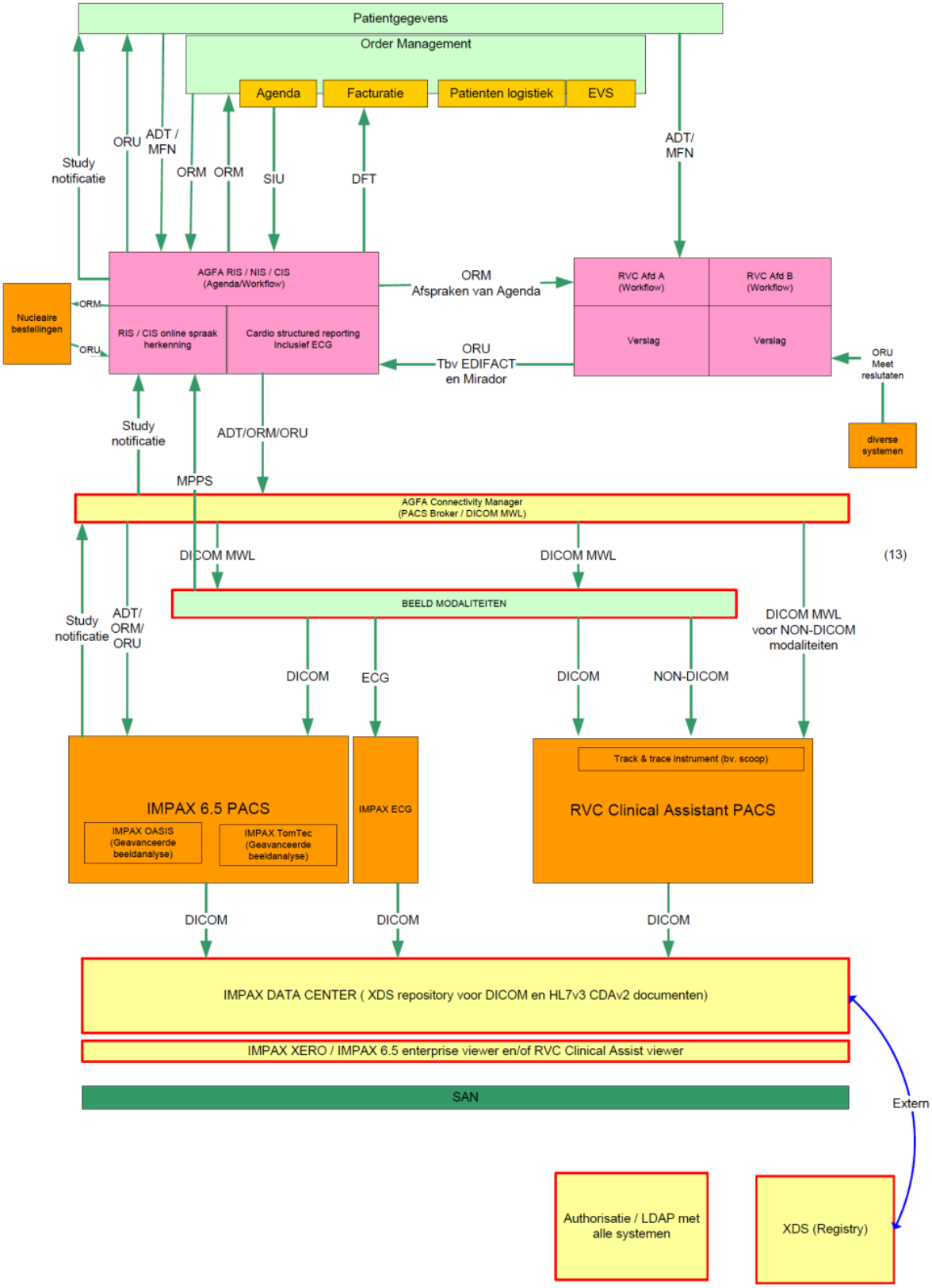




Appendix 7. Epic Technical Architecture



Appendix 8. PACS Internal Module configuration



Appendix 9. Relations to knowledge items

The displayed graphs are configured with a relation depth of two, so not only the direct relation is visible but the second degree relation too. This gives more insight in the functionality of the relation. In some cases it is advisable to create clarity about the impact of new products. For example training for a Caché database don't say much, but the operational databases of the new EHR makes the urgency a lot higher.

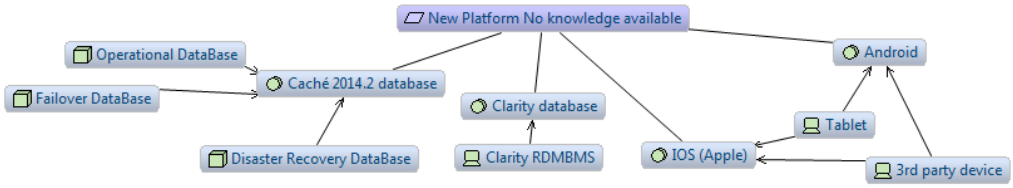


Fig. A9.1 New Platforms with no knowledge available with the team

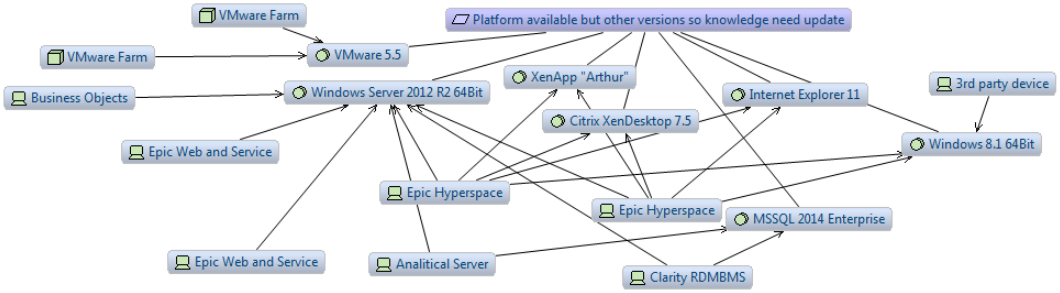


Fig. A9.2 Platform Updates where knowledge needs to be updated

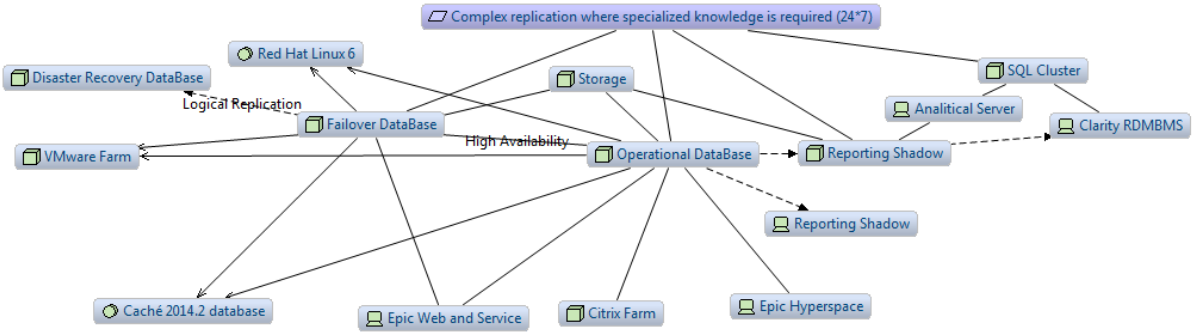


Fig. A9.3 Complex configurations

Appendix 10. ISO 25010 Product quality

Functional suitability	degree to which a product or system provides functions that meet stated and implied needs when used underspecified conditions. • **Functional completeness** : "degree to which the set of functions covers all the specified tasks and user objectives" • **Functional correctness** : "degree to which a product or system provides the correct results with the needed degree of precision" • **Functional appropriateness** : "degree to which the functions facilitate the accomplishment of specified tasks and objectives"
Performance efficiency	performance relative to the amount of resources used under stated conditions • **Time behaviour** : "degree to which the response and processing times and throughput rates of a product or system, when performing its functions, meet requirements" • **Resource utilization** : "degree to which the amounts and types of resources used by a product or system, when performing its functions, meet requirements" • **Capacity** : "degree to which the maximum limits of a product or system parameter meet requirements"
Compatibility	degree to which a product, system or component can exchange information with other products, systems or components, and/or perform its required functions, while sharing the same hardware or software environment • **Co-existence** : "degree to which a product can perform its required

	functions efficiently while sharing a common environment and resources with other products, without detrimental impact on any other product" • **Interoperability** : "degree to which two or more systems, products or components can exchange information and use the information that has been exchanged"
Usability	degree to which a product or system can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use • **Appropriateness recognizability** : "degree to which users can recognize whether a product or system is appropriate for their needs" • **Learnability** : "degree to which a product or system can be used by specified users to achieve specified goals of learning to use the product or system with effectiveness, efficiency, freedom from risk and satisfaction in a specified context of use" • **Operability** : "degree to which a product or system has attributes that make it easy to operate and control" • **User error protection** : "degree to which a system protects users against making errors" • **User interface aesthetics** : "degree to which a user interface enables pleasing and satisfying interaction for the user" • **Accessibility** : "degree to which a product or system can be used by people with the widest range of characteristics and capabilities to achieve a specified goal in a specified context of use"
Reliability	degree to which a system, product or component performs specified functions under specified conditions for a specified period of time • **Maturity** : "degree to which a system, product or component meets needs for reliability under normal operation" • **Availability** : "degree to which a system, product or component is operational and accessible when required for use" • **Fault tolerance** : "degree to which a system, product or component operates as intended despite the presence of hardware or software faults" • **Recoverability** : "degree to which, in the event of an interruption or a failure, a product or system can recover the data directly affected and re-establish the desired state of the system"
Security	degree to which a product or system protects information and data so that persons or other products or systems have the degree of data access appropriate to their types and levels of authorization • **Confidentiality** : "degree to which a product or system ensures that data are accessible only to those authorized to have access" • **Integrity** : "degree to which a system, product or component prevents unauthorized access to, or modification of, computer programs or data" • **Non-repudiation** : "degree to which actions or events can be proven to have taken place, so that the events or actions cannot be repudiated later"

	• Accountability : "degree to which the actions of an entity can be traced uniquely to the entity" • Confidentiality : "degree to which a product or system ensures that data are accessible only to those authorized to have access" • Authenticity : "degree to which the identity of a subject or resource can be proved to be the one claimed"
Maintainability	degree of effectiveness and efficiency with which a product or system can be modified by the intended maintainers • **Modularity** : "degree to which a system or computer program is composed of discrete components such that a change to one component has minimal impact on other components" • **Reusability** : "degree to which an asset can be used in more than one system, or in building other assets" • **Analysability** : "degree of effectiveness and efficiency with which it is possible to assess the impact on a product or system of an intended change to one or more of its parts, or to diagnose a product for deficiencies or causes of failures, or to identify parts to be modified" • **Modifiability** : "degree to which a product or system can be effectively and efficiently modified without introducing defects or degrading existing product quality" • **Testability** : "degree of effectiveness and efficiency with which test criteria can be established for a system, product or component and tests can be performed to determine whether those criteria have been met"
Portability	degree of effectiveness and efficiency with which a system, product or component can be transferred from one hardware, software or other operational or usage environment to another • **Adaptability** : "degree to which a product or system can effectively and efficiently be adapted for different or evolving hardware, software or other operational or usage environments" • **Installability** : "degree of effectiveness and efficiency with which a product or system can be successfully installed and/or uninstalled in a specified environment" • **Replaceability** : "degree to which a product can replace another specified software product for the same purpose in the same environment"

Appendix 11. Resource calculation

expertise	proces SLM	Quality	Change	Incident	Operations	CMDB	30% Projecten	uren/wk	FTE
(5 FTE Legacy; 6 FTE EPIC)								396	11
Ontwerp	8	8	40				72		
Applicatiesupport	8	8	80	40			72		
Gebruikerssupport	12	4	10	34					
							108	468	13
Applicatiesupport	6	8	36	36	30	2			
Intake		2	24						
Packagen		2	22	12					
Omgevingmanagement		2	12	10	12				
Office support		4	12	20					
Sharepoint		4	20	24	20	4			
Link		1	10	15	10				
Monitoring									
								108	3
Beheer		8	20	20	36				
Monitoring				20	4				
							18	126	3,5
Design		2			6				
VPN			4	2					
Switching			8	1	4	2			
Vlan / Routing			4	1	2				
IP adress management			1	1	2	1			
Patching			16	2	1				
Access control			4						
DMZ			6	4	8	2			
Monitoring		4		8	12				
							18	90	2,5
Basis Linux beheer		2	8	8	2				
Design					4				
Hardware beheer		2	8	4	6				
Monitoring		4		12	12				
							72	288	8
Basis windows beheer		2	16	16	16	2			
Hardware beheer		1	4	4	4	1			
User beheer			4	2		2			
SAN			2	2	1	1			
Vmware		1	2	2	2	1			
Blade servers			2	1	1	1			
Design					4				
Printque management		1	8	8	4	1			
SCCM			4		2				
AppV		1	2	1	2	1			
Citrix		1	2	1	2	1			
Xenapp		1	2	1	2	1			
Xendesktop		1	2	1	2	1			
Xenserver		1	2	1	2	1			
Exchange			12	10	12	2			
Monitoring			4		16				
								36	1
Backup		2	1	4	4				
Restore		2			8				
DRP test		4	2	1	8				
							36	144	4
SQL			6	18	12	1			
Oracle			6	12	8	1			
Progress			2	1	1				
Caché			4	4	8	1			
Clarity			4	4	10	1			
Monitoring					4				
								216	6
Call intake			36		72				
1e lijn support				72					
User beheer			24	12					
								144	4
PC inrichten			24	24					
PC Plaatsen			20			2			
Printer storing / toner			4	8	4				
GSM			4	4					
Tablet			12			2			
Verhuizingen			24	4		8			
								108	3
Programmeren centrale			16	8	8	2			
Programmeren callcentre module			4	4	4	2			
Plaatsen telefoons			16	8					
Programmeren DECT			6	4	1	2			
Ondersteuning Smartphone			2	1	1				
Patchen			16	2	1				
Changemgr			36					36	1
Incidentmgr				36				36	1
Quality								9	0,25
SLM								9	0,25
Projectleiding							144	144	4
Teamleiding								108	3
Architect								36	1
Back Office								108	3
Stand By				72				72	2

Epic beheer:			proj uren/wk	540	74,5
omgeving mgr	**1**		proj FTE	15	
koppelingen	**2**				
DMZ	**0,5**				
Linux	**1**				
Windows 1/2 win 1/2 citrix	**1**		5 FTE legacy	6 FTE EPIC	
sql	**1**				
Caché en Clarity	**1**				
beschikbaarheid WPB	**1**				
Mobile devices	**1**				
	9,5				
Standby verbetering					
5 expertises beschikbaar	**5 x 9,2**				
gemiddelde duur meldingen	**26**				

Totaal	
	FTE
Huidig IBS	**30,5**
Func beheer	**11**
sharepoint	**2**
Link	**1**
Projecten	**15**
Epic beheer	**9,5**
Standby	**2**
Pink en VCD	**3,5**
Totaal	**74,5**

rekening houdend met huidig beheer Pink en VCD wat overgaat naar intern beheer